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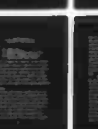
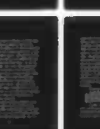
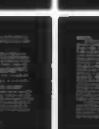
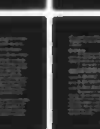
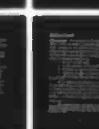
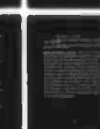
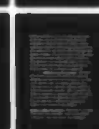
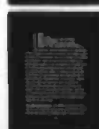
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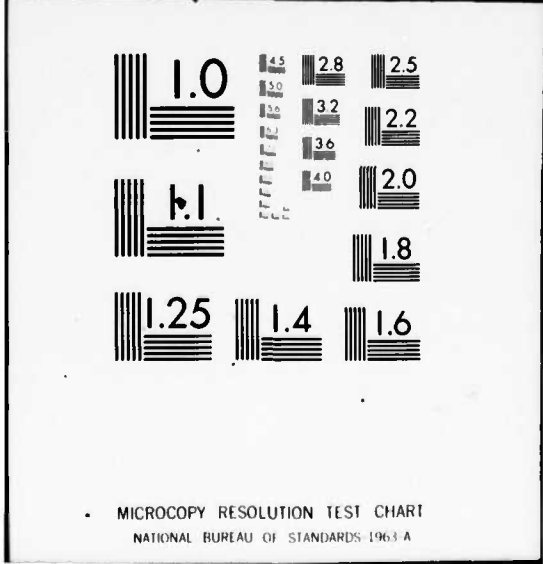
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AND PERCEIVED USABILITY OF
C-141A JOB GUIDES,

⑩ S. A. Richardson Lieutenant Colonel, USAF
Thomas E. Syster Captain, USAF

⑭ AFIT⁷-LSSR 36-77B

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The C-141A was the first aircraft to use job guides. In 1976 AFHRL conducted a survey at the two bases which participated in the development of these job guides to determine their usability and degree of user acceptance. This thesis conducted a similar survey at two bases which did not participate in the development of the C-141A Job Guide to determine if user attitudes about job guides was as favorable as found by AFHRL. Also tests were made to determine if there was any difference in attitudes between pay grades. Behavioral theory suggests that workers who participate in planning a change will have less resistance to that change and that younger workers resist change less than older workers. It was concluded that technicians at bases which did not participate in the development of the C-141A Job Guides had a lower acceptance of them, but there was no difference in perceived usability. No significant difference was found between grades for either user acceptance or perceived usability. Although acceptance of the C-141A Job Guides was high, actual on-the-job use of them appeared to be quite low, and could eliminate anticipated cost savings as suggested by previous experiments with job guides. <

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AN ANALYSIS OF USER ACCEPTANCE AND PERCEIVED
USABILITY OF C-141A JOB GUIDES

A Thesis

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the
Degree of Master of Science in Logistics Management

By

S. A. Richardson, BS
Lt Col, USAF

Thomas E. Syster, BA
Captain, USAF

September 1977

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This thesis, written by

Lieutenant Colonel S. A. Richardson

and

Captain Thomas E. Syster

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN LOGISTICS MANAGEMENT

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Michael B. McCormick
COMMITTEE CHAIRMAN

Dale R. Van Kenney
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Chapter 1

INTRODUCTION

Statement of the Problem

During 1975, the Military Airlift Command (MAC) elected to replace their standard dash-2 series C-141A Technical Orders with Job Guides. This change was made under the Air Force Logistics Command (AFLC) Technical Order Improvement Program. Aircraft maintenance personnel at two MAC bases--Charleston AFB, South Carolina and Norton AFB, California--were involved in the development of the C-141A Job Guides. After development, the job guides were initially distributed at the same bases on a test basis. Air Force Human Resources Laboratory (AFHRL) personnel subsequently conducted a study at the two test bases to determine user acceptance and perceived usability of the C-141A Job Guides and to identify existing or potential problems encountered in the changeover to the new system. The results of the study with regard to user acceptance and perceived usability of job guides were favorable. However, since Charleston and Norton AFBs participated in the development and initial implementation of the C-141A Job Guides, user

acceptance and perceived usability at these two locations may actually have been more favorable than at other MAC bases. A follow-on study was needed to determine if user acceptance and perceived usability of the C-141A Job Guides were as favorable at other MAC bases as they were at the two bases which participated in the development and initial implementation of the C-141A Job Guides (21).

Background

Job performance aids research. Over the last two decades a number of small-scale experiments have been conducted on new ways of presenting maintenance information. These experiments dealt with maintenance information that was people-oriented rather than equipment-oriented. The maintenance information used in these experiments has been primarily referred to as job performance aids (JPA). The JPAs ranged on a continuum from very specific step-by-step procedures to more general descriptions of the system being maintained. Most of these experiments focused on the use of very specific step-by-step procedures for non-troubleshooting tasks. They differed primarily in the degree of proceduralization of

instructions for troubleshooting tasks. The experiment results generally demonstrated that JPAs had the potential to reduce the mean-time-to-repair of equipment faults, improve the accuracy of fault diagnosis, and reduce the amount of technician training required (37:8-9).¹ Two of the experiments with JPAs are discussed below because they are typical of the results obtained in other experiments, and they also deal specifically with the C-141A aircraft.

Project PIMO (Presentation of Information for Maintenance and Operation) was one of the most extensive experiments carried out with JPAs. The project included a large scale field evaluation conducted primarily at Charleston AFB, South Carolina, in 1968, using JPAs for organizational level maintenance of the C-141A. One kind of JPA, fully proceduralized aids for non-troubleshooting maintenance tasks (more commonly referred to as job guides) was compared with traditional documentation using both experienced and inexperienced

¹A critical evaluation of each of the experiments was made by Rowan (37) whose study is highly recommended for the reader who wishes to review this area more closely.

personnel. The most significant result was that in over 1,000 observations of non-troubleshooting tasks performed with job guides, not one error was observed. The experienced personnel were able to perform the maintenance faster with traditional documentation. However, after repeated use of the job guides, repair time approached the time required when using traditional documentation. Significantly, apprentice technicians were able to perform non-troubleshooting tasks without error using job guides in slightly more time than experienced technicians using job guides. Additionally, experienced technicians were tested on troubleshooting tasks using both simplified maintenance dependency charts and traditional technical orders. The results showed an 11 percent reduction of mean-time-to-repair when the maintenance dependency charts were used. Also, only one error was made, as opposed to 12 when the traditional documentation was used (37:21-23).

Another experiment was performed by AFHRL during 1975 and 1976 using recent graduates of the Keesler Technical Training Center and technicians from McChord AFB, Washington; Travis AFB, California; and McGuire AFB, New Jersey. This experiment was designed to compare

the effectiveness of fully proceduralized troubleshooting aids (FPTAs), logic tree troubleshooting aids (LTTAs) and technical orders (TOs) for supporting maintenance personnel of varying experience levels performing troubleshooting tasks. Thirty specific troubleshooting test problems on the AN/APN-147 (radar) and AN/ASN-35 (computer) systems of the C-141A aircraft were used in the evaluation. The experiment was conducted in the field using a van which contained a working mock-up of the two systems. The experience levels of the technicians were: Recent graduates of the technical training course (no field experience), technicians with less than six months experience, and technicians with more than six months experience. Eighteen technicians for each of the experience levels were used in the experiment. However, the no-experience group was tested using only FPTAs and LTTAs. The experiment showed that proceduralized troubleshooting aids (FPTAs and LTTAs) produced significantly better results than the TOs. This finding held for two of the three measures used: number of problems successfully solved and the number of spare parts consumed. On the third measure, time to troubleshoot, the TOs were better at the organizational

maintenance level and the proceduralized troubleshooting aids were better at the intermediate maintenance level. In comparing the FPTA to the LTTA it was found that the FPTA was better in all measures except time to troubleshoot for experienced technicians at the organizational maintenance level (35:1-2). Additionally, this experiment was significant because it was one of the few studies on job performance aids which also ascertained the subjective opinions of the participants on the three types of data used. The FPTA was given the highest rating by all groups as the most helpful in troubleshooting. The TOs received the lowest rating (35:83).

Development of C-141A job guides. In 1972, AFLC, with approval from Headquarters United States Air Force (HQ USAF), initiated its Technical Order Improvement Program (TOIP) to replace traditional TOs on selected older aircraft. This program is developing job guides for the C-141A, B-52G/H, KC-135, F-106, and F-5 aircraft. The C-141A Job Guides were the first to be developed under this program. HQ USAF has directed that job guides will be procured for organizational maintenance of all new weapon systems, including the F-16 and the A-10 (22:3).

A contract was awarded to the Westinghouse Electric Corporation for the development of the C-141A Job Guides. The development of the job guides was not limited to the reformulation of the existing C-141A TOs. Instead, the contract with Westinghouse called for a detailed task analysis of the C-141A maintenance requirements. As a result of this task analysis, some 2,000 maintenance tasks were identified and included in the job guide series. The existing TOs only covered 1,100 maintenance tasks. Part of the development of these job guides took place at Charleston AFB. After the job guides were developed, they were implemented at Charleston AFB during September 1975 and at Norton AFB during October 1975 prior to MAC-wide implementation. The purpose of the two-phase implementation was to identify and correct errors and usage problems before the job guides were implemented at the remaining MAC bases (22:9). Early in the implementation period at Charleston and Norton AFBs, emphasis was placed on identifying the errors in the data so that they could be corrected quickly via expedited AFTO Form 22s (22:27). MAC-wide implementation of the job guides took place between March and May 1976 (1:1).

Description of C-141A job guides. The C-141A Job Guides consist of a series of technical data for all on-equipment maintenance. Existing TOs for in-shop work were retained. Although the entire series of on-equipment technical data is commonly called job guides, the job guide manual (JGM)² is just one of five distinctive types of manuals provided. It is presented in 4 by 8 inch format, while the remaining four types are presented in 8½ by 11 inch format. The entire series is generally characterized by clear and concise information, specific illustrations located near the text, and the use of standardized verbs to prevent confusion. The concept is for all the information required to do a task, including the tools, test equipment, and personnel required, to be given in one location, in order to reduce or eliminate referencing other TOs. In addition, special effort is generally made to present the level of detail required by the projected user. The job guide series consists of the following five distinctive types

²The term "job guides" will be used throughout the rest of this thesis to refer to the whole series of manuals. The abbreviation of job guide manual, JGM, will be used to refer specifically to the 4 by 8 inch manuals which provide the proceduralized step-by-step instructions.

of manuals; JGM, maintenance support information manual (MSIM), general aircraft manual (GAM), wiring diagram manual (WDM), and logic tree troubleshooting aid (LTTA) (22:3-6).³

AFHRL study. In May 1975, AFHRL agreed to help MAC introduce the new technical data for the C-141A and collect very limited opinion data about the acceptance of the new technical data (12:1). During May 1975, a conference on "Improved Information Aids for Technicians" was convened at Department of Defense (DoD) level. As a result of this meeting, the Air Force was requested by the Office Assistant Secretary Defense/Installations & Logistics (OASD/I&L), to perform an analysis of costs/benefits of the TOIP data acquired for the C-141A. Subsequently, HQ USAF tasked AFLC,⁴ MAC, and AFHRL to include in their analysis the ease of use and acceptability by the user of the C-141A Job Guides (20:1).

³A description of each of these five distinctive types of manuals is contained in Appendix A.

⁴The Productivity Reliability Availability and Maintainability (PRAM) office in ASD was later designated as the office of primary responsibility for the subject analysis which was originally assigned to HQ AFLC (9:1).

The data for the AFHRL study were collected at Charleston AFB and Norton AFB during the period July 1975 to July 1976. The study was broken down into the following three phases.

1. Phase I consisted of collecting personal attitudes from the user population before the use of job guides was implemented. The primary method used to collect the data was a questionnaire. Interviews with supervisory personnel were also conducted (22:8).

2. Phase II took place during November 1975 (six to ten weeks after the implementation of job guides) (23:1,31:1). The data collected during this phase represented the early learning period after the initial exposure to job guides. The data were collected using a questionnaire which was administered to both inexperienced and experienced personnel. Also, interviews were conducted with a representative sample of technicians and supervisors. Informal observations were made to permit the researchers to obtain first-hand information on how the technical data were used and what problems were encountered (22:8).

3. Phase III was conducted eight to nine months after the implementation of job guides at Charleston AFB

and Norton AFB. It was felt that early administrative and usage problems would be corrected and user attitudes stabilized by the beginning of Phase III (22:8). During Phase III, data were collected by 314 questionnaires and 150 interviews with individuals and groups. Observations were also made of work in progress (22:37).

The preliminary findings of the study showed that of those technicians who completed a brief questionnaire during Phase II, 80 percent indicated they preferred the job guides to the old technical data. Inexperienced military and supervisory personnel expressed the most positive attitudes towards the new data. Experienced military personnel and civilians in non-supervisory positions were most likely to express unfavorable attitudes towards the data (23:2).

The data obtained in Phase II were categorized into acceptance and usability factors. Acceptance referred to the attitude of the users toward the data. Usability was a term used to identify those factors which encouraged or discouraged the normal use of the new job guides on the job (22:13). Attempts to categorize factors as acceptance or usability during Phase III were found to be very difficult. Thus,

observations and findings during this phase were classified merely as positive and negative factors affecting usability and acceptance (22:37). These findings are summarized in Appendix B.

Scope

As previously stated, the AFHRL study of C-141A Job Guide user acceptance and perceived usability was conducted at the two bases which were involved in the development and pre-implementation test of the job guides: Charleston AFB and Norton AFB. The scope of this thesis effort was confined to an empirical analysis of additional data collected by questionnaire at two other CONUS C-141A bases and a comparison of the additional data with data collected by questionnaire at Charleston and Norton AFBs during Phase III of the AFHRL study. Due to time and funding constraints imposed by the academic environment, no on-site interviews or task observations, such as those conducted by AFHRL, were made. The absence of on-site interviews and task observations is a limitation because explanations of significant differences found between the two samples were restricted to an analysis of questionnaire responses.

Justification for the Research

The steadily increasing cost of maintaining Air Force (AF) weapons systems, together with current austerity programs, make it essential that improved methods for reducing maintenance costs be found. One approach that has been increasingly investigated is the use of improved types of technical data. Job guides are such an attempt to improve the content and method of presentation of technical data. Evidence from experiments and field tests, which have been conducted using job guide-type technical data, suggest that significant cost savings could result from use of job guides (37:43). Theoretically, savings should result because of more productive utilization of maintenance technicians, increased equipment in-commission rates, reduced consumption of spare parts, and reduced training requirements (35:15). These cost savings could be substantial. For example:

. . . in 1969 [there were] approximately 5,700 aircraft mechanics assigned to flight line maintenance of the C-141A. Assuming only 1,000 new men per year due to turnover, and a per man cost of \$3,500 for OJT and \$4,500 for formal training, over \$7,000,000 per year could be saved in this specialty by cutting training from 28 to 4 weeks [37:48-49].

The DoD is extremely interested in what is being done by the three services in the area of maintenance performance aids (33:1). In 1975 DoD tasked the AF to conduct an extensive evaluation of the C-141A JGMs and LTTAs (16:1). This evaluation was considered essential "since Job Guide Manuals and Trouble Shooting Aids are to be the new way of business in the Air Force [17:1]." This evaluation would form the basis for decisions regarding the implementation of job guides for other AF weapon systems scheduled to convert to job guide technical data and for the use of job guide technical data in the Army and Navy.

Our long range intent is not merely to demonstrate but to actually effect increased performance and cost savings in all three areas: materiel, training, and manpower. Based on previous research efforts by [the] Air Force these savings should be achievable while improving the technician's performance and improving the readiness of our equipment [17:1].

Even though the job guide concept has been well tested, some questions remain regarding the use of job guides in an operational environment. One such question is how will technicians respond to the requirement to use them on a day-to-day basis (22:1)? The conversion to the use of job guides for C-141A maintenance provided the first opportunity to answer this question. Thus,

the AFHRL study of job guide user acceptance and usability was the initial attempt to seek an answer to this and other questions. However, since the bases where this study was conducted were involved in the development and initial shake-down testing of the job guides, a follow-on study at other bases was necessary in order to obtain a more objective evaluation of user acceptance and usability of the C-141A JGMs. Although AFHRL recognized the need for a follow-on study, and OASD (I&L) had requested it, AFHRL did not have the available manpower to devote to such a follow-on study (21).

Objectives

The objectives of this research effort were:

1. To measure current attitudes of C-141A maintenance technicians toward C-141A Job Guides at two bases which did not participate in the development and pre-implementation testing of the C-141A Job Guides.
2. To compare user acceptance of C-141A Job Guides as measured by this survey with user acceptance as measured by the AFHRL Phase III survey questionnaire.
3. To compare perceived usability of C-141A Job Guides as measured by this survey with perceived

usability as measured by the AFHRL Phase III survey questionnaire.

4. To compare user acceptance of C-141A Job Guides by the pay grade of the respondents.

5. To compare perceived usability of C-141A Job Guides by the pay grade of the respondents.

Objective 1 involved no statistical testing as did the other four research objectives. The data collected to accomplish Research Objective 1 were used to conduct the statistical tests by which Research Objectives 2 through 5 were satisfied.

Research Hypotheses and Statistical Hypotheses

The research hypotheses and statistical hypotheses were derived from Research Objectives 2 through 5. Support or non-support for the statistical hypotheses was determined through the use of statistical tests. Support or non-support for the research hypotheses was determined through the use of criteria tests. The direction and nature of the results were anticipated in each case on the basis of the review of the

literature.⁵ Specific research hypotheses and statistical hypotheses tested were:

Research Hypothesis 1 (Statistical Hypotheses 1 through 3). Technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides have a higher degree of acceptance of the job guides than do technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 1 (H_1). Technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides like the new job guides better than do technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 2 (H_2). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides prefer job guides over other styles of

⁵See Figure 1 for an explanation of the relationship between the research hypotheses and statistical hypotheses and their relationship to the research objectives.

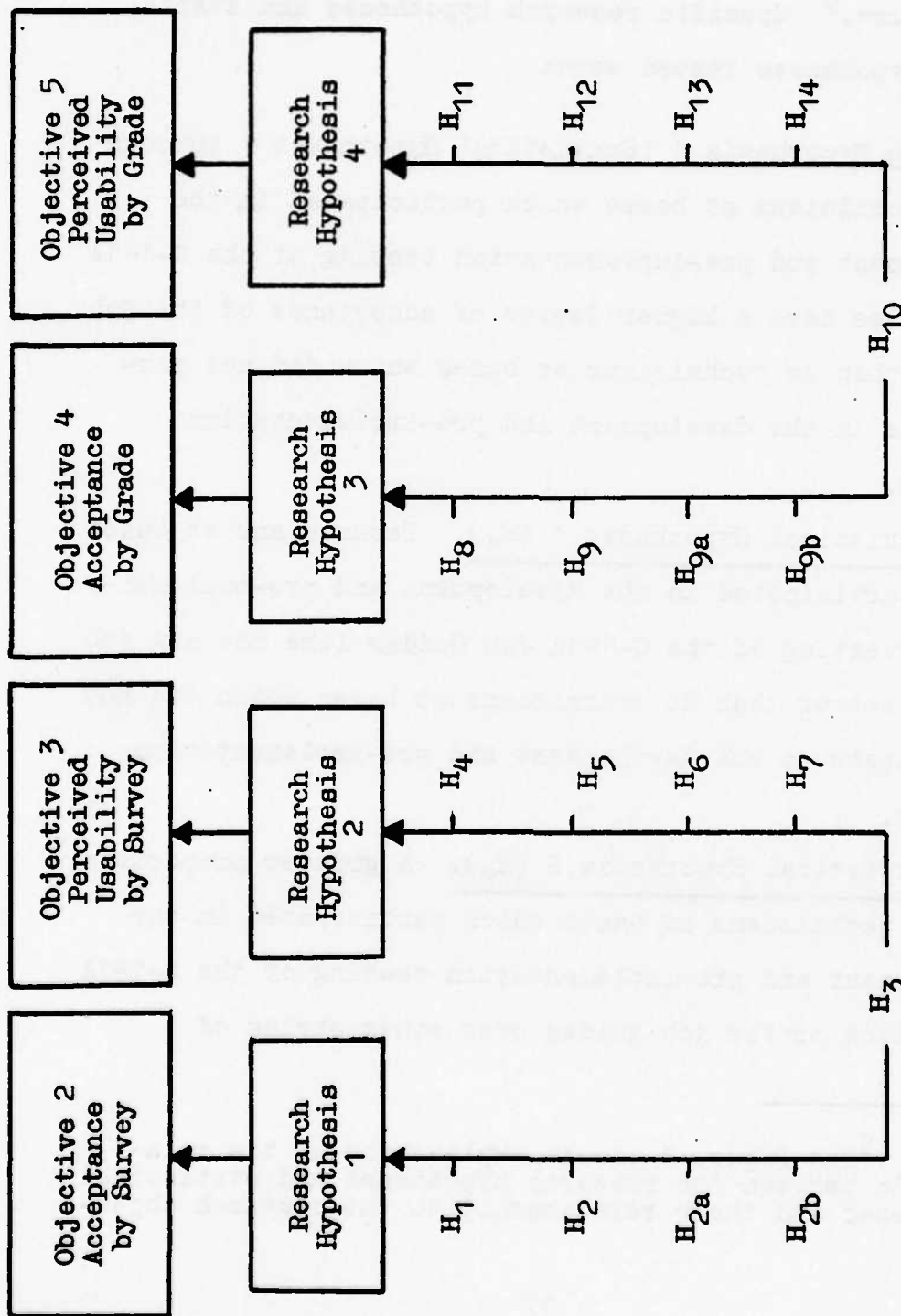


Figure 1

Relationship of Objectives, Research Hypotheses, and Statistical Hypotheses

technical data than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 2a (H_{2a}). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides prefer JGMs over other styles of technical data for routine jobs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 2b (H_{2b}). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides prefer JGMs over other styles of technical data for non-routine jobs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 3 (H_3). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that they use JGMs more than the old TOs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Research Hypothesis 2 (Statistical Hypotheses 3 through 7). Technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides perceive the job guides to be more usable than do technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 3 (H_3).⁶ A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that they use JGMs more than the old TOs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 4 (H_4). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that JGMs are a better source of information for their jobs than the old TOs than does the proportion of the technicians at the bases which did not participate in the development and pre-implementation testing.

and 2. ⁶ H_3 is relevant to both Research Hypotheses 1

Statistical Hypothesis 5 (H_5). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that job guides are more valuable for on-the-job training (OJT) than the old TOs than does the proportion of the technicians at the bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 6 (H_6). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that JGMs and LTTAs will help them do their job better than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 7 (H_7). A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that LTTAs require less time to troubleshoot than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

Research Hypothesis 3 (Statistical Hypotheses 8 through 10). Lower grade technicians have a higher degree of acceptance of the job guides than do higher grade technicians.

Statistical Hypothesis 8 (H_8). Lower grade technicians like the new job guides better than do higher grade technicians.

Statistical Hypothesis 9 (H_9). A greater proportion of lower grade technicians prefer job guides over other styles of technical data than does the proportion of higher grade technicians.

Statistical Hypothesis 9a (H_{9a}). A greater proportion of lower grade technicians prefer JGMs over other styles of technical data for routine jobs than does the proportion of higher grade technicians.

Statistical Hypothesis 9b (H_{9b}). A greater proportion of lower grade technicians prefer JGMs over other styles of technical data for non-routine jobs than does the proportion of higher grade technicians.

Statistical Hypothesis 10 (H_{10}). A greater proportion of lower grade technicians feel that they use JGMs more than the old TOs than does the proportion of higher grade technicians.

Research Hypothesis 4 (Statistical Hypotheses 10 through 14). Lower grade technicians perceive the job guides to be more usable than do higher grade technicians.

Statistical Hypothesis 10 (H_{10}).⁷ A greater proportion of lower grade technicians feel that they use JGMs more than the old TOs than does the proportion of higher grade technicians.

Statistical Hypothesis 11 (H_{11}). A greater proportion of lower grade technicians feel that JGMs are a better source of information for their jobs than the old TOs than does the proportion of higher grade technicians.

Statistical Hypothesis 12 (H_{12}). A greater proportion of lower grade technicians feel that job guides are more valuable for OJT than the old TOs than does the proportion of higher grade technicians.

Statistical Hypothesis 13 (H_{13}). A greater proportion of lower grade technicians feel that JGMs and IITAs will help them do their job better than does the proportion of the higher grade technicians.

⁷ H_{10} is relevant to both Research Hypotheses 3 and 4.

Statistical Hypothesis 14 (H_{14}). A greater proportion of lower grade technicians feel that I/TAs require less time to troubleshoot than does the proportion of higher grade technicians.

Chapter 2

THEORETICAL JUSTIFICATION

Before proceeding further, it is beneficial to examine the theoretical justification for the research hypotheses. Essentially, the theoretical justification provided the very basis for the belief that user acceptance and perceived usability of the C-141A Job Guides would not be as favorable at other MAC bases as at the two bases which participated in the development and initial implementation of the job guides. In any organizational change, some resistance to change is likely to occur (44:470). Therefore, it is extremely important to understand some of the theoretical aspects of human behavior regarding planned organizational change. This chapter addresses, in broad terms, the resistance phenomenon by looking at how attitudes are formed, why resistance to change occurs, and how resistance to change might be reduced in an organizational setting.

Overview

Change within an organization can be viewed two ways: natural and planned. Natural change in an organization takes place over a period of time through

a process of evolution. Natural change includes changes brought about gradually by such things as personnel turnover and technological advances (8:225). The second view of organizational change is that of planned change. This concept assumes the organization can identify gaps between its present condition and some desired condition (25:578). In planned change a conscious decision is made by management to effect an improvement in some dimension of the organization (8:225;25:578). Authors on the subject of planned change typically refer to it as planned organizational change. However, this does not mean that they are referring to only changing the organizational structure of an organization. Planned organizational change has a much wider connotation. It can refer to changing any dimension of the organization such as product appearance, structure, morale, formal communications networks, and work procedures (8:229;25:578). It is planned organizational change that will be referred to in the theoretical justification for this thesis.

Writers on the subject of planned organizational change refer to entities (individual, groups, or organizations) in need of some kind of help as "Client Systems" (8:226). Persons or groups providing assistance to the

client system are referred to as "Agents of Change" which may or may not be part of the client system. The condition which client systems want to achieve are called "Target Goals" (8:226). Champion notes that:

It seems to be the case in numerous instances of organizational change that the lower-level participants collectively view change as a serious threat to the status quo (which it is) and to their jobs (which it might be) [8:229].

These feelings can give rise to resistance to change which hinder the implementation of the changes or prevent them from taking place at all.

With these thoughts in mind, the theoretical justification evolves from an examination of the relationship of attitudes to resistance to change in an organization, primarily at the lower working level. The first step in understanding this relationship will require defining what an attitude is; briefly reviewing the various components of attitude formations and how attitudes might be changed; identifying the major functions of attitudes; and then examining some of the ways attitudes are developed in an organizational setting. The next step, after considering the broad background of attitudes, will be to evaluate the issue of resistance to change in organizations, specifically at

the lower levels. This approach necessitates an analysis from both the individual's and group's standpoint. The final step will be to focus on participation as one of the primary means to reduce resistance to change by first looking at some specific examples where participation was effective in reducing resistance to change. Some examples where participation was ineffective in reducing resistance to change will then be examined in order to draw certain conclusions on what elements of participation are, or are not, effective in reducing resistance to change.

Attitudes

Definition of the term "attitude" is as dynamic and varied as the nature of the individuals or groups who determine its origin and justify its very existence. Authoritative contributions by students of the subject vary widely. According to Harry C. Triandis, noted psychologist, an attitude is an idea which is charged with emotion predisposing a class of actions to a particular class of social situations (41:3). In 1935 Gordon Allport reviewed the general area of attitude theory and research and offered several considerations for deeper thought.

After considering more than one hundred different definitions of attitude, Allport concluded that most investigators basically agreed that an attitude is a learned predisposition to respond to an object or class of objects in a consistently favorable or unfavorable way. Furthermore, he pointed out that this bipolarity in the direction of an attitude (i.e., the favorable versus the unfavorable) is often regarded as the most distinctive feature of the concept. Thus attitude was conceptualized as a simple undimensional concept [40:17].

Milton Rokeach theorizes that an attitude is a relatively enduring organization of interrelated beliefs which describe, evaluate, and advocate action with respect to an object or situation, with each belief having cognitive, affective, and behavioral components. He further elaborates that each of these beliefs is a predisposition, which when appropriately stimulated or activated, results in some preferential response toward the attitude object, person, or situation (36:132).

Other noted authorities of the behavioral sciences, including Triandis, appear to generally agree that an attitude is thus characterized by three components--cognitive, affective, and behavioral. These attributes are further defined below as part of the examination of the term attitude, which in itself is now simply suggested as primarily a way of being "for" or "against" certain things.

The cognitive component--perceiving, knowing, believing--is the informational content of any attitude (30:360). For example, in an individual's attitude toward top management the stereotyped beliefs (valid or not) he may hold about the management staff's ability, appearance, and habits.¹

The way the individual feels--his likes or dislikes--for the top management staff represents the affective component of the attitude. In other words, the affective aspect embodies the evaluative nature of the attitude (30:360). It follows then that the degree of evaluation, or intensity of the attitude, refers to the strength of the affective component (11:253).

Later, the tendency to exhibit overt behavior toward top management, or predisposition to action, suggests the conative, or behavioral component of attitude (30:361). The behavioral component, which stems

¹Costello and Zalkind, co-authors of Psychology in Administration, state that all attitudes include beliefs, but not all beliefs are attitudes. Attitudes include both the effective, or feeling core of liking or disliking; and the cognitive, or belief elements, which describe the objective of the attitude, its characteristics, and its relations to other objects. When specific attitudes are organized into a hierarchical structure, they then make up value systems (11:253).

from the cognitive and affective components, may be characterized by either an aggressive or passive nature. For example, if line members of the organization violently oppose and refuse to implement a decision by top management to establish a new work schedule, the behavior may be considered aggressive in the extreme. However, if the same decision is opposed but reluctantly accepted by the line members, then the behavior component may be considered passive.

J. W. McGuire viewed components of attitudes in an interesting way by considering them either favorably or unfavorably.

As a rule, favorable attitudes are characterized by positive directions for all three attributes; unfavorable attitudes tend to involve the reverse. Nevertheless, one may experience hearty dislike without the usual cognitive basis (i.e., without knowing). Or he may behave aggressively (conative) without feeling hostile (affective) [30:361].

To effect an attitude change simply infers a change in predisposition, with " . . . the change being either a change in the content of one or more of the beliefs entering into the attitude organization [36:135]." A change in attitude can first occur by changing the cognitive component (for example, by presenting new information), the affective component

(by pleasant or unpleasant experience in the presence of the attitude object), or the behavioral component (by norm change, or the legal imposition of behavioral change). An attitude change can also take place by forcing an individual to act or by presenting him with a proven fact. When any one of the components has changed the others are likely to follow (41:143).

Functions of attitudes. Turning to functions of attitudes, it has been said that attitudes can be viewed as a means to other ends; that they:

. . . function to facilitate the achievement of goals, retrospectively on the basis of past pleasant experiences or in prospective anticipation of future reward [30:361].

But does an attitude embody drive-producing properties or does the motivation stem from sources other than the attitude itself? Apparently this question was an issue of continuing controversy among the behavioral scientists in much earlier times (36:129).

Over the past few decades, however, more comprehensive understanding of the functions of attitudes were presented by such noted figures as Freud and Lasswell (1930s) and Fromm and Maslow (1940s). The suggestion was offered and widely accepted that attitudes serve

mainly irrational, ego-defensive functions (36:129). Subsequent to, and under the influence of these ideas, plus continuing advances made by noted authorities in the behavioral field, Daniel Katz (1960) presented a highly refined formulation that attitudes serve four major functions (36:130). Katz suggested that these four functions can be grouped according to their motivational basis expressed as follows (11:255,256).

1. The adjustive function. This function is a recognition of the fact that people strive to maximize the rewards in their external environment and minimize the penalties. Therefore, the attitudes acquired in the adjustment function are either means for reaching the desired goal or avoiding the undesirable one.

2. The ego-defensive function. This function is reflected in an individual who protects himself from acknowledging basic truths about himself or the harsh realities in his external world. These devices stem basically from internal conflict with its resulting insecurities.

3. The value-expressive function. When an individual derives satisfaction from expressing attitudes consistent with his own personal values and self

image, then the value-expressive function comes into play. This function supports the concept of ego psychology which stresses the importance of self-expression, self-development, and self-realization.

4. The knowledge function. The search for meaning, the need to understand, the need to organize perceptions and beliefs to provide clarity and consistency describe the knowledge function. People need standards or frames of reference for understanding their world, and attitudes are a useful medium to serve this cause.

Development of attitudes. Closely associated with the functions of attitudes are the determinants of attitude development. "In addition to perceiving what they expect to perceive, people also have a tendency to perceive what they want to perceive [8:4]." Therefore, the major determinants of learning also play a role in the formation of attitudes. Accordingly it has been stated that the more important of these determinants are the family, the culture (or society), class, and various peer groups (11:260). The last two determinants--class and peer groups--provide the most important framework for this discussion.

Each individual is influenced in one way or another by the many class groups of which he is a part.

Geographic, religious, educational, and socio-economic class group membership all provide a person with norms or standards as to what attitudes he 'should' learn. . . . many attitudes growing out of the individual's group memberships are relevant to the work situations and industrial society. For example, as the individual grows he forms attitudes toward management and labor. These are influenced by his own socio-economic class [11:261].

Such class influences are likely to be found in any bureaucratic organizational setting, whether industrial or government.

Closely associated with the class determinant is the influence generated by an individual's peer groups as well as prior work experience. Costello and Zalkind expressed it this way:

The reliance on other's opinions shows itself as the individual moves out beyond the family into other groups, his own peer groups. Initially other children, playmates, acquaintances, and friends, later, perhaps students, then co-workers and others with whom he comes in contact, become influences on his attitudes. He may think they are right or he may simply not wish to risk disapproval, but his attitudes will in part be shaped by them. . . . by the time he goes to work in a specific organization (particularly if it is not his first job) he will hold many attitudes concerning such areas for example, as pay, working conditions, company policies, the way he should be supervised and the way of supervising others. He will have attitudes about the way work should be done, what

constitutes a day's work, the way people should be treated, and the ways to sell a product [11:262].

The influence of these attitude determinants within various dissatisfied groups (class and/or peer groups) can have far reaching and quite often disastrous consequences for an organization's effectiveness in either formal or informal organizational settings. As Champion points out:

Distorted rumors transmitted by informal grapevines to organizational members can lead to all kinds of serious outcomes. Misunderstandings between superiors and subordinates (latent or expressed) can foster apathy among employees and deliberate slowdowns or absenteeism. To the extent that distortions of information are perceived as bringing about changes in one's job, employee fears and anxieties are aroused, and the workers lose trust in those over them. Another concomitant or distortion of information may be resistance to change to new programs introduced by higher-ups. Although subsequent formal channels of communication may provide the members of the organization with accurate information, sufficient damage may already have been inflicted upon organizational effectiveness [8:190].

The development and subsequent influence of individual and group attitudes quite often present mystifying phenomena to an unknowing or unenlightened management. Organizational objectives and goals, particularly as they relate to planned organizational changes, can be hampered or delayed by group attitude formations which are not consistent with those of top

management. Keeping the foregoing discussion in mind, this raises the question of why resistance to change can occur in organizations?

Why Resistance to Change Occurs in Organizations

A review of the literature reveals an almost overwhelming preponderance of reasons why resistance to change is a common reaction in the face of a planned organizational change. In order to confine the discussion of this subject to reasonable limits, reasons which are not applicable to the lower levels of an organization have been eliminated. To provide some sort of organization the remaining reasons have been broken down into two categories: Why individuals resist change, and why groups resist change. The placement of reasons into one category or the other could be argued in some cases; however, in order to facilitate the discussion, they have been arbitrarily placed in the category which seemed most obvious to us. To further facilitate the discussion reasons have been combined within each category into homogeneous groups.

Individual reasons. Reasons why individuals resist change fall into three homogeneous groupings: Threat

to job security, sunk costs, and new working conditions.

1. Threat to job security. A real or imagined threat to job security can cause an individual to resist change (8:243). In the military the threat of actual job loss is probably not as great as in other organizations. However, there is an equal threat of loss of status or role, which may also be viewed as a threat to job security. This is more important to older individuals who have built up their status over the years (8:243). For example, a change in procedures, for which a senior noncommissioned officer (NCO) has been known as the unit expert, could threaten some of the status of that NCO in the organization. If the changes were drastic he would no longer be considered an expert to the extent he was previously and thus lose much of his status in the eyes of the organization. This threat may be real or imagined. The threat often is caused by inadequate information received through the informal grapevine (13:469).

Of crucial importance is uncertainty about the consequences of a change. Speculation and rumor about negative consequences are typically part of the change process. Given little explicit information, an environment of uncertainty will lead people to assume the worst. The obvious result is vigorous resistance to proposed change [25:584].

2. Sunk cost. Sunk cost can also help to explain individual resistance to change. The term "sunk cost", as used here, is not limited to just past expenditures of money, but has a wider connotation which also includes past expenditures of time and energy (13:468;26:583). An individual may have made a considerable investment of time or energy and a change which threatens to reduce the value of his investment may produce resistance to change (13:468). Sunk cost is closely related to threat to job security or status as discussed above. However, the concept of threat to job security or status refers to loss of the results of an individual's investment, while the concept of sunk cost refers more to the loss or diminishing value of the investment itself. Change, particularly of procedures, often involves re-education which may be regarded by some individuals with hostility and antagonism (8:243). Thus, the concept of sunk cost helps to explain why younger individuals tend to resist change less than older ones. Younger individuals have invested little in the old system and, therefore, do not have as much to lose (13:469). Usually a younger individual is, prior to the change, still involved in the learning

process and does not view additional training as a threat. The only difference to him is that now the content of instruction will be changed. Whereas, an older individual may consider that he has completed the learning process and can now reap the benefits of his education and settle into an easier routine. A change of procedures means that he may have to begin the learning process again and thus disrupt his established routine. If the change involved eliminating or revising some procedure or technique actually developed by an individual, his resistance to change might be expected to be even greater, due to his pride of authorship (11:195).

3. New working conditions. Finally, change may threaten new conditions at work (11:227). Again, this threat may be real or imagined. The fear and anxiety which often accompany a change may well be heightened by inadequate and distorted information received via the informal grapevine (13:460). Even if there is no threat to loss of status or re-education involved in the change, it may involve the threat of a change in routine. As Filley, House, and Kerr point out, "many people will resist any change which threatens to disturb their state of equilibrium [13:469]."

Typically, individuals may imagine the work will be harder or the work environment may not be as pleasant.

Group reasons. In this category are included five major reasons why groups resist change: group norms, shift of power, hostility towards the agent of change, personality of the group, and the informal group. The first of these areas, group norms, is based upon all the reasons why individual attitudes can influence and help form group attitudes. It was for this reason that the discussion of why individuals resist change was placed prior to the discussion of why groups resist change.

1. Group norms. Even if an individual himself has no objection with a proposed or pending change, his attitude may be affected by someone else in the group. Studies have shown "that information which comes from respected, trusted or favored sources . . . receives exceedingly high weight in people's perceptions [13:64]." Even if an individual feels that a change is rational and should be accepted, he may still resist it, as pointed out by Kerr and Kerr.

By hanging out a 'do not disturb' sign over established rules, customs, and procedures, the group may influence an individual to oppose changes he would rationally support. To the group members the organization's penalty for resisting

the change may seem far less severe than the group's probable penalty for opposing its norms [26:470].

The Coch and French experiments at the Harwood Manufacturing Corporation support this view that group standards may provide more powerful motivation for an individual than motivation induced by management. In one group tested the study showed that the group standard to restrict production after a change was a major reason for decreased production (10:341,349).

2. Shift of power. The perceived shift of power away from the group can cause resistance to change (13:472;25:585). Within an organization rivalry frequently arises between different organizational groups. This type of rivalry is frequently observed between maintenance and operations in a U.S. Air Force wing. In this situation the group wants to be the best and most important group within the organization. Any proposed change, whether it is proposed by another competing group within the organization or by top management itself, which is perceived to shift power away from the group, will probably be resisted (13:472). It makes little difference if their loss is some other groups gain or if the loss is perceived as an equal across-the-board

loss for all competing groups. "The change, although good for the organization, might weaken or destroy their functional area [11:195]." In this situation the group may resist the change because it perceives a loss or decrease of control in its own affairs (25:585).

3. Hostility towards the agent of change.

Another reason groups resist change is hostility toward the agent of change (8:243). In a military organization the agent of change is frequently "headquarters." In some military organizations "headquarters" is often perceived as the enemy. The unit might argue if it weren't for headquarters the unit would do fine. Changes proposed by headquarters are frequently resisted by the unit because the changes are seen as meddling in unit affairs. This observation is supported by Gardner and Whyte who have observed "that line personnel will resist change, particularly if it is introduced by the staff contingent [8:242]."

4. Personality of the group. The personality of the group may also have a bearing on its predisposition to resist change. A group which perceives itself to be superior to others will often resist change (13:473). According to Argyris, in an effort to present changes

rationally, management frequently gives reasons for change with terms like "to increase effectiveness." This implies to the group that management does not perceive them as being effective now, and the group resents it (4:72). One could continue in this vain by hypothesizing that the group resists change in an effort to prove or assert to management that they are now effective.

5. The informal group. Finally, change might be resisted by the group because of fears that it may alter the informal group. Because group members find the present informal relationship satisfying, they are likely to resist any changes which they perceive as disruptive to their informal relationships (8:243).

It should be noted that many of the reasons cited for group resistance to change can also become internalized by the individual and become an individual reason for resistance as well. Thus, in reality you cannot separate the individual from the group, because they both interact on each other. With this thought in mind it is now important to consider some ways in which resistance to change might be reduced or avoided.

Participation as a Primary Means to Reduce Resistance to Change

Considerable literature exists dealing with planned organizational change. Most of it offers some hints on how to make a planned change successful. However, there is one theme which seems to permeate much of the literature on resistance to change. This recurrent theme is summarized well by Champion.

Meaningful participation by employees in changes which are designed to affect them will yield greater cooperation, higher morale, and a change of considerably longer duration than programs dictated to organizational members by writ from figures of authority [8:234].

This conclusion is echoed by Filley, House, and Kerr who also offer a subtle warning.

Overall, the weight of evidence indicated that involvement of individuals in the change process does tend to lessen resistance to change and to facilitate the change process. However, there appear to be a number of exceptions to this general rule . . . [13:494].

The rest of this chapter will deal with this concept of participation² as a means to reduce resistance to change and its effects, pro and con.

²Participation is referred to as a process in which two or more parties influence each other in making plans, policies, and decisions. It is restricted or limited to decisions that have future effects on all those making the decisions and on those represented by them (15:3).

Many authorities agree a direct relationship exists between the amount of employee participation in change and the degree of employee acceptance of change (19:437). This relationship is probably best expressed in the following study by Coch and French.

The Harwood Manufacturing Corporation experiment. One of the classic studies dealing with worker participation was conducted by Coch and French (10) at the Harwood Manufacturing Corporation. The plant had been plagued with a high degree of worker resistance to change which was expressed in the form of grievances, high turnover, low efficiency, and marked aggression towards management. Coch and French set up several experiments which involved the workers planning for the change. Essentially, the study showed the production rate to be directly proportional to the degree of participation by the workers and the turnover and aggression rates to be inversely proportional to worker participation (10:342-344). They also found that group standards had a great deal to do with the production rate.

Whether this power of the group over the members was used to increase or to decrease productivity seemed to depend upon the use of participation [10:349].

The increased group standards in the participating groups seemed to be due to their competition with other groups.

Coch and French concluded that

It is possible for management to modify greatly or to remove completely group resistance to changes in methods of work and the ensuring piece rates. This change can be accomplished by use of group meetings in which management effectively communicates the need for change and stimulates group participation in planning for the changes [10:350].

Weighing the findings and conclusions of the Harwood experiment, the advantages of employee participation in change were enumerated as follows (19:438).

1. Participation produced positive effects on morale and labor-management relations.
2. The technical program developed more rapidly, employees cooperated and brought problems to management's attention.
3. The new method eventually evolved as the brain-child of the workers themselves, giving employees pride and a feeling of accomplishment.
4. Participation as a form of communication gave employees some of the reasons why changes must come.

Other supporting studies. Other studies have also been conducted which confirm the findings of Coch and French.

Lewin found that Red Cross study groups which had group discussions after lectures changed more than study groups which had no group discussions after lectures (13:492). A follow up study by Pelz concluded that group discussion was not the important factor but rather it was the fact that the group reached a decision and a consensus of opinion was perceived by the group (13:492). Both of these studies clearly showed the value of participation in reducing resistance to change. Another study by Morse and Reimer also showed the positive benefits of participation. Their study looked at changes in the jobs of clerical workers.

One program, defined as the 'autonomy program' increased each person's role and significance in the anticipated changes. The other program, designated as the 'hierarchically controlled program,' was set up to decrease each person's influence (i.e., high-level managers made decisions for the lower-level personnel). They found that in general individual satisfactions increased substantially in the autonomous program and decreased substantially in the hierarchically controlled program [3:236].

More recently a study by Lawler and Hackman found that attendance increased considerably in groups that participated in developing an incentive plan for attendance. In groups that did not participate in developing the plan there was no corresponding increase (13:493).

Elements of participation which are effective in reducing resistance to change. Based on these and other studies the following factors seem to be the most critical to the effective use of participation as a means to reduce resistance to change. The reader is cautioned to keep in mind that the factors cited are arranged in four broad categories which exhibit varying degrees of interdependence. In some cases these categories could be further broken down to stand alone; however, typically the factors still appear to suggest a strong interrelationship which collectively influence the success of participation.

1. Perception. How an individual perceives change is vital in reducing resistance to change. The organization members' response to change invariably depends upon his perception of the proposed change and the effect he thinks the change might have on his needs and aspirations. Confirming or changing perceptions through participation provides an individual with an understanding of all facets of the problem under consideration as well as a clearer definition of the objective (28:326). If he perceives change to be compatible with his personal goals and participation confirms this belief, then there are few problems (26:470-472).

2. Stake. The element of stake is predicated on the process of planning for change. Individuals who help plan a change are in a better position to appreciate why it is needed and how such a change can bring about improvement in the organization, the work group or their jobs. As Carvell puts it:

By participating in the planning of change, employees have a stake in the success of that change. . . . In such a case, a change would stand a much better chance for success if the need for the change were seen or suggested by the worker himself rather than being imposed by his superiors [7:150].

Research evidence tends to support the contention that involving individuals in the planning process will increase their commitment to the organizational goals and objectives (18:87). Mann and Neff advise that participation by individuals in decision-making regarding problems which concern them is important in terms of motivation. It gives them an opportunity to contribute ideas and instills a sense of responsibility for the success of the decision (28:326). It gives them a stake in the management effort.

3. Needs and values. According to Maslow, all human beings have a hierarchy of needs, and as the most urgent need is satisfied, others assume a greater

priority (25:83,257-258). Positive results are obtained in reducing resistance to change when personal needs and values are satisfied in the organization. For example, the Harwood Corporation management staff advocated that a job is done best when employees feel that their needs are considered in such a way that sustains their self-respect. When employees participate they do not feel the humiliation implied in the term "hired hands" or that they are mere robots (29:27). French maintains that when management provides the workers participation in any important decision, it implies that workers are intelligent, competent, and valued partners. He indicates that participation directly affects such aspects of worker-management relations as the perception of being valued, the perception of common goals, and cooperation. And it also satisfies such important social needs as the need for recognition and appreciation and the need for independence. These satisfactions, plus the improvement in their jobs introduced through participation, lead to higher job satisfaction (15:5).

4. Mutual confidence. The element of mutual confidence between the management and employee personnel is an essential ingredient of the participative process

in reducing resistance to change. Marrow looks at it this way:

. . . a participative approach to problem-solving can succeed only when there is mutual confidence. Then employees and managers are trusting and open and problems can be approached in a spirit of joint inquiry and a consensus worked out. Harwood found that participation leads to more loyalty, more flexibility, and more efficiency. Relationships on the job shift from competition to cooperation. A sense of mutual interdependence develops [29:27].

Hodge advocates the importance of mutual confidence and trust in participation in the context of reducing resistance to change.

For participation to be completely effective, employees must feel that their comments will not bias their position in any way; they must state their feelings and opinions, rather than what others expect to hear. Only then can true resistance be brought to the surface and effectively eliminated [19:439].

At this point the merits of participation will be left to rest on these findings and the other end of the spectrum will be examined in order to determine when participation is ineffective in reducing resistance to change.

Limitations of Participation in Reducing Resistance to Change

Sometimes resistance to a planned change occurs even if management has considered all the factors and

made a concerted effort to reduce resistance with tried and tested procedures. In such a situation, management would be well advised to consider the words of Lawrence.

When resistance does appear, it should not be thought of as something to overcome. Instead, it can best be thought of as a useful red flag--a signal that something is going wrong. To use a rough analogy, signs of resistance in a social organization are useful in the same way that pain is useful to the body as a signal that some bodily functions are getting out of adjustment.

The resistance, like the pain, does not tell us what is wrong but only that something is wrong. And it makes no more sense to try to overcome such resistance than it does to take a pain killer without diagnosing the bodily ailment [27:472].

Participative management can have positive and lasting results in reducing resistance to change, but it may not be equally applicable in all organizations. It must be remembered that successful use of participative management depends upon the situation. While the participative management approach tends to be effective in some American industrial settings, it may not be appropriate in other countries. This argument was illustrated quite clearly when French, Israel, and others attempted to replicate the Harwood experiment in an overseas factory (18:88).

The Norwegian factory experiment. The main purpose of the field experiment in Norway in 1965 was to repeat the

Coch and French experiment using a more precise theory of participation and more careful empirical methods. A secondary purpose of the study was to discover if the general results of the Coch and French experiment would hold in a different culture (15:3).

The factory at which this experiment was conducted was located in a small town in southern Norway and employed about 1,600 personnel, having been decreased to that number (from 2,100 in 1948) by updating production processes with new modern equipment. At the same time that the work force was being reduced, a production increase of 30 percent was experienced in some departments. The experiment was carried out in the footwear department which employed approximately 400 workers, both male and female. In this department almost identical work groups of four workers each do all the assembly operations. Nine of the four-person groups took part because they were going to be changed to a new product. The four control groups were changed by the usual methods, but the five experimental groups were allowed more participation. Each of the five experimental groups met with their foreman and representatives of the planning department to plan which of the five new products should

be assigned to each of the five experimental groups. Two of the experimental groups held two additional meetings in which they participated in decisions regarding the division of labor into four jobs, the assignment of those jobs to group members, and the training for the new jobs (15:7,17,18).

Questionnaire responses demonstrated that all three types of meetings produced psychological participation, i.e., a perception in the workers that they had high influence on the decisions made. However, unlike the Harwood experiment there was no difference between the experimental and control groups in the level of production achieved. Other findings showed that with respect to worker-management relations, there was support for the hypothesis that the effects of participation are applicable only to subjects who experience no more participation than they consider legitimate. Thus, cultural factors are important: the Norwegian workers had a stronger tradition of being organized in a union than had the American factory workers. This in turn could produce an attitude that the legitimate pattern of participation is through union representatives rather than direct participation (15:18).

In summary, French found no significant difference in productivity between work groups in which participative management was used and those in which it was not used. Participation helped to produce improved morale only to the extent that (1) the workers felt they had no more influence on planning the changes than they thought they should have, and (2) there was no strong resistance to the methods of introducing change. The study results suggested that cultural differences and the situation may be important in determining the appropriate management style. In other words, increased participation in the decision-making process did not have the same positive influence on factory workers in Norway as it did at the Harwood Corporation (15:18;18:88;28:326).

Factors which limit participation in reducing resistance to change. Participation has its limits as well as its advantages. Drawing on the review of the Norwegian study and other case examples, three categories of factors which limit the effectiveness of participation will be identified. Here too, as with the positive aspects of participation, there is an interdependence or relationship reflected between categories.

1. Timing. In contrast to those who advocate participation as the principal means for making organizational changes, there are those who believe that some changes should be mandated by management without using the participative technique. Timing and situational factors are important determinants in these cases. For example, when ethical, moral, or religious considerations are at stake in making a change, managers may have to make a decision without the group's participation. In some cases the affected personnel may not have the technical experience or background expertise to accurately measure the impact of necessity of a change (7:148,149).

The timing element can be costly also. Inappropriate timing in participation may result in a decision that comes too late for strategic effectiveness plus involving large expenditures of man-hours and energies. For example,

If a crude oil pipeline breaks down, the man in charge of maintaining a flow of raw materials to the refinery served by the pipeline must act fast to arrange alternate sources of supply. At most, he has only brief consultations with other people, and he must brush aside a detailed examination of the best possible sources in making sure that the refinery can continue to operate without interruption. Participation would mean costly delays [34:538]

Even when there are no emergency situations and pressures, the time element required for participation may be a serious obstacle to its effective use. In the face of change and even on small matters it should be considered whether participation justifies the time it takes away from other work (34:538,539).

2. Personalities, interests, and capabilities.

Individual personalities, interests, and capabilities are often key factors in limiting the effectiveness of participation. Studies by Vroom and Tannenbaum have shown that the outcome of psychological participation varied depending upon the personality characteristics of the participant. They suggest that authoritarians and persons who do not have a strong need to be independent are not favorably affected by participation. They point up the importance of carefully analyzing the personality needs and values of individuals who may be affected by a major change (28:326,327).

Research has shown that the participative approach to management may be based upon a greatly over-emphasized notion about people. Noted psychologist Clare Groves has identified four fairly distinct personality types which are not believed suited for participation.

. . . at the bottom of his well-ordered hierarchy he places the childlike 'autistic' personality, which required 'close care and nurturing.' Next up the scale are the 'animistic' type, which must be dealt with by sheer force or enticement; the 'ordered' personality that responds best to a moralistic management; and the 'materialistic' individual who calls for pragmatic, hard bargaining. None of these are suited for the participative kind of management [3:373].

Champion also advises that given the many individual differences which exist among the personnel of any organization, it is likely that increased participation in decision-making and job satisfaction may be inversely related for some. He points out that some workers prefer the safety of not being required to make decisions (8:219). This observation is further substantiated by the findings in the Norwegian factory experiment which showed that workers would accept no more participation than they thought was needed or legitimate. Also, it should be noted that there is a strong interrelationship between personalities and values, and skills and abilities. Without appropriate skills and abilities on the part of both manager and worker, participation will not function. Not only must the supervisor be skilled in creating an atmosphere that invites participation, the subordinate must have the necessary abilities to

make it work. Obviously if either of these factors is lacking, the successful use of participation is lacking (14:387,388). A high mental ability is desirable, even though a participant need not be exceptional in all respects. However, he does need strength in at least one of the following intellectual qualities: Originality, penetrating analysis, good memory, or balanced judgement. Participation by unintelligent personnel clearly must be restricted to limited phases of simple problems (34:540).

3. Manipulation. Nothing will limit or destroy the successful designs of participation more quickly than manipulation of the participants. Mann and Neff warn that management should try to obtain the benefits of encouraging employee participants through real, not apparent participation. They (Mann and Neff) point out that people tend to see through such guises, and react negatively quite rapidly to change (28:327). Newman, Summer, and Warren echo this theme and advise that participation is not always desirable.

If economic realities or other forces restrict possible alternatives, an executive should not try to fool his subordinates that they are helping to reach what is a foregone conclusion [34:547].

They also point out that when participation is used merely as a motivational device, subordinates are led

to believe that their ideas are being solicited sincerely, but the soliciting executive has little or no real interest in their suggestions. Sooner or later the employees will sense that what is being done under the guise of participation is really an attempt to manipulate them into supporting the management's ideas and decisions. Soliciting participation at this point is more likely to do more harm than good if the subordinates feel that management is insincere in its request (34:542).

Summary

It is realized that these basic views on theoretical justification have been quite extensive and elaborate. However, this approach was considered essential in forming a comprehensive basis for analyzing user acceptance and perceived usability of C-141A Job Guides. Without this theoretical background the accurate interpretation of data relevant to the research hypotheses and the formation of meaningful conclusions would be exceedingly difficult.

The key points are that individual and group attitudes quite often comprise the very backbone of reasons for the resistance to change phenomenon.

Individual reasons for resistance to change include threat to job security, sunk cost of older individuals, and the fear and anxiety of new working conditions. Group reasons include the influence of group norms, a loss of group power, hostility toward the agent of change, the overall personality of the group, as well as a fear of altering the informal group organization.

In considering numerous ways to avoid resistance to change, direct participation by the individual or group in the change process has proven successful in a majority of cases. Participation has a potential to increase the accuracy of individual and group perceptions of the change as it affects their needs and aspirations, to give the participants a stake in the change, to satisfy personality needs and values, and to create an atmosphere of mutual confidence and trust between manager and subordinate.

On the other hand participation may not be a "cure all" for reducing resistance to change. Factors limiting the use of participation include: timing; personalities, interests and capabilities of the participants; and manipulation of subordinates instead of true participation.

The theoretical concepts presented in this chapter assist in synthesizing ensuing discussions and treatment of the research hypotheses. Of specific importance in the formulation of the Research Hypotheses 3 and 4 was the observation that, all other things being equal, younger individuals tend to resist change less than older individuals because they have less invested in the present system. The formulation of Research Hypotheses 1 and 2 was based upon the observation that participation in a planned change, by the workers affected, frequently reduces their resistance to that change.

Chapter 3

METHODOLOGY

Introduction

This chapter describes the methodology used to conduct this research. Included is a discussion of the following: the development of the survey questionnaire, the procedures used for sampling, the statistical techniques used, and the practical decision rules upon which conclusions were based. At the end of this chapter is a list of assumptions and limitations of this study.

The Survey Questionnaire

The survey questionnaire was designed to gather data in three general areas: (1) demographic information, (2) user acceptance of C-141A Job Guides, and (3) perceived usability of C-141A Job Guides. A copy of the survey questionnaire is included as Appendix C.

The demographic data were used to identify differences between various categories of respondents.

The specific demographic data gathered were:

1. Grade
2. AFSC
3. Skill level
4. Type of squadron to which assigned
5. Base of assignment
6. Where first used C-141A Job Guides
7. Length of time in aircraft maintenance
8. Length of time working on C-141A aircraft.

The questions seeking information on respondents' length of time in aircraft maintenance and length of time working on C-141A aircraft were not included in the AFHRL questionnaire. These two questions were added to the survey questionnaire on the recommendation of AFHRL (39). The question asking respondents where they first used C-141A Job Guides was added to determine if any of the respondents had been reassigned from Charleston AFB or Norton AFB since implementation of job guides. Respondents who indicated they first used job guides at Charleston AFB or Norton AFB were excluded from the sample. There was only one such respondent. The rest of the questions in the survey questionnaire were taken primarily from the questionnaire used by AFHRL during Phase III of their study.

The AFHRL questionnaire. The AFHRL questionnaire consisted of 37 questions, 36 of which were multiple choice and one which was an open-ended essay. A copy of the

AFHRL questionnaire is included as Appendix D. The questionnaire was designed to determine if the C-141A Job Guides were accepted by maintenance technicians and if the technicians considered the C-141A Job Guides to be usable. Included in the questionnaire were eight questions, questions 25 to 32, from a different questionnaire administered during Phase I before the implementation of job guides. These questions were used as a basis for comparing technicians' attitudes about job guides before and after the job guides were implemented (22:54).

Prior to the development of the questionnaire used in this study, an analysis was performed of the AFHRL questionnaire. This analysis resulted in the classification of the 36 multiple choice questions on the AFHRL questionnaire into two classes according to the intended purpose of the question: questions dealing with acceptance and questions dealing with perceived usability. This classification generally agreed with the classification of questions found in the AFHRL study (22:56-63). However, an attempt was made to classify all questions, which was not done in the AFHRL study.

1. Acceptance of C-141A Job Guides. This category included questions which either directly or indirectly

measured acceptance of C-141A Job Guides by maintenance technicians. Some of the questions measured overall acceptance of C-141A Job Guides while others measured acceptance of specific features of the C-141A Job Guides. This classification also included several questions which measured acceptance of C-141A Job Guides by asking respondents which of several types of technical information they preferred to use for different kinds of jobs. All questions which were included in this classification have been marked with an asterisk in Appendix D.

2. Usability of C-141A Job Guides. This category included questions which measured how usable the respondents perceived the C-141A Job Guides to be. Some of the questions dealt with general usability, while others dealt with the usability of specific features or usability for specific purposes. Some of the questions asked the respondents to specifically compare the usability of job guides to the usability of the old C-141A TOs. All questions not marked with an asterisk in Appendix D were included in this category.

Changes to AFHRL questionnaire. Respondents to the AFHRL questionnaire were encouraged to make written comments in addition to selecting multiple choice responses

provided on the questionnaire. Comments were encouraged when respondents could not find a suitable response or they felt the question was unclear. These written comments served as a validity check on the AFHRL questionnaire. The validity of the 36 questions on the AFHRL questionnaire was discussed with AFHRL personnel who recommended that minor changes be made to several questions (39). Thus, several updated questions were included in the survey questionnaire used in this study. Appendix E discusses the recommendations made by AFHRL and the changes made to the original questions used by AFHRL.

Several other questions on the original survey could have been better stated. However, no attempt was made to change the wording of questions, other than those discussed in Appendix E. For comparative analysis it was important to make the survey questionnaire similar to the AFHRL questionnaire.

Additional questions. Three additional questions, number 46 through 48, were added to the survey questionnaire. They were intended to determine:

1. The extent of JGM use.
2. What most influenced respondents' preference for job guides..
3. What most influenced respondents' preference for the old C-141A TOs.

Survey questionnaire validity. Validity of the survey questionnaire was established by discussing with AFHRL personnel the problems they encountered with their questionnaire and written comments made by various respondents (39). Additional critical reviews were conducted by the Research and Administrative Management Department, School of Systems and Logistics; HQ MAC; and the Air Force Military Personnel Center (AFMPC). Also, respondents were encouraged to write comments on the questionnaire when all of the available responses were inadequate, or the question was unclear. This procedure provided additional after-the-fact validity of the survey questionnaire.

Variables for Testing¹

User acceptance. User acceptance is the degree of acceptance of C-141A Job Guides by C-141A maintenance technicians. Although all five questions selected for testing measure acceptance and are, therefore, related, each question deals with a distinct aspect of acceptance. The aspects of acceptance examined were:

1. How well are JGMs liked?
2. Overall preference for job guides?
3. Preference for JGMs for routine jobs?
4. Preference for JGMs for non-routine jobs?
5. Are JGMs being used more than the old TOs were used?

For H_1 through H_3 the distribution of responses on the current survey for each of the questions selected for testing was compared to the distribution of responses on the AFHRL Phase III survey. The objective was to determine if a statistically significant difference

¹See Appendix F for a clarification of the relationship of the variables for testing, the hypotheses, the survey questions, the level and classification of data for each variable, and the appropriate statistical test.

exists. For H_8 through H_{10} the distribution of responses on the current survey for each of the questions selected for testing was compared by the grade of the respondents. The objective was to determine if a statistically significant difference exists between grades.

Overall, 16 questions were classified as measuring user acceptance (see Appendix D). Only five of these questions were selected for testing. The remaining 11 questions either measure acceptance indirectly or measure acceptance of specific features of job guides. These questions were viewed as providing reasons why respondents accept, or do not accept, job guides in general.

Perceived usability. Perceived usability is how usable the C-141A maintenance technician feels that the C-141A Job Guides are. Perceived usability was measured by responses to five questions. Although all five questions selected for testing measure perceived usability and are, therefore, related, each question deals with a distinct aspect of perceived usability. The aspects of perceived usability examined were:

1. Are JGMs being used more than were the old TOs?

2. Are JGMs better than the old TOs as a source of information for the respondent's job?

3. Are job guides more valuable than the old TOs for OJT?

4. Will JGMs and LTTAs help the respondent do his job better?

5. Do LTTAs require more or less time to troubleshoot a problem?

For H_3 through H_7 the distribution of responses on the current survey for each of the questions selected for testing was compared to the distribution of responses on the AFHRL Phase III survey. This comparison was designed to determine if a statistically significant difference exists. For H_{10} through H_{14} the distribution of responses on the current survey for each of the questions selected for testing was compared by the grade of the respondent. This comparison was designed to determine if a statistically significant difference exists between grades.

Overall, 18 questions were classified as measuring perceived usability (see Appendix D). Only five of the questions were selected for testing. The remaining 13 questions either measure usability indirectly or measure perceived usability of specific features of job guides.

These questions were viewed as providing reasons why respondents feel that job guides are or are not usable in general.

The Population

The population of interest consisted of all active duty enlisted and civilian aircraft maintenance technicians who met all of the following five criteria:

1. Were assigned to McChord or McGuire AFB.
2. Were assigned to an Avionics Maintenance Squadron (AMS), Field Maintenance Squadron (FMS), or Organizational Maintenance Squadron (OMS).
3. Used C-141A Job Guides in the normal performance of their duties.
4. Were in pay grade E1, E2, E3, E4, E5, E6, E7, E8, E9, WG 10, or WG 11.
5. Did not receive their first exposure to C-141A Job Guides at Charleston or Norton AFB.

The population of interest excluded commissioned officers, wing staff personnel, civilians in pay grades other than WG 10 or WG 11, and C-141A aircraft maintenance technicians assigned to locations other than McChord or McGuire AFB. This is a limitation and precludes the generalization of the results of the survey beyond the population of interest.

Sampling Plan

The sampling plan was designed to provide data that could be meaningfully compared with the data gathered by AFHRL. The sample of 314 subjects gathered by AFHRL during Phase III of their study was not a completely stratified random sample. This condition arose because personnel participation in the AFHRL study was only allowed on a non-interference basis. At the two bases sampled by AFHRL, each of the three maintenance squadrons was asked to provide 40 to 50 technicians representative of the squadron in terms of grade, AFSC, and experience. AFHRL believes that the resulting sample was fairly representative of the maintenance population at both bases (22:55). The current study assumed that the AFHRL sample was representative of the population and that the two data bases could be compared without limitation in terms of the distribution of responses to individual questions.

In order to maintain as much comparability as possible between the sample for this survey and the sample solicited by AFHRL, HQ MAC provided a stratified, randomly selected list of 150 C-141A maintenance technicians from both McChord AFB and McGuire AFB. The 150

names from each base were equally divided between AMS, FMS, and OMS and stratified with 75 percent military and 25 percent civilians. The sample was limited to the AFSCs which were identified in the AFHRL survey. In addition, a list of 30 alternates was provided for each base. The project officers at McChord AFB and McGuire AFB were instructed to select technicians from the alternate list of respondents if any of the primary respondents were unavailable. This procedure for using alternates was not considered to be a limitation, as the list of alternates was also generated by a random selection process, and was considered desirable to avoid an inordinate delay in the return of the completed questionnaire.

According to Headquarters USAF

A confidence/reliability level of '95% \pm 5%' for survey results is the minimum one normally specified and desired by all professional surveying organizations. The figure 95% is the confidence coefficient and the \pm 5% is the confidence interval [2:11-12].

In order to achieve a confidence/reliability level of 95% \pm 5% the following general formula is given by Headquarters USAF for computing the minimum sample size from a known finite population.

$$n = \frac{N(Z^2) \times p(1-p)}{(N-1)(d^2) + (Z^2) \times p(1-p)}$$

Where:

n = sample size,
 N = population size,
 p = maximum sample size factor (.50),
 d = desired tolerance (.05), and
 Z = factor of assurance (1.96) for
 95% confidence level [2:12].

After the sample was requested, it was learned that the population of interest consisted of 1783 technicians. To meet the desired confidence level criterion sample of 316 was required. Therefore, the two base project officers were instructed to transfer ten names from the alternate list to the primary list. This procedure provided a total sample of 320 primary respondents.

Data Collection

The survey questionnaire, together with a list of primary and alternate technicians randomly selected by HQ MAC, was distributed to a project officer at each base. Project officers were identified by HQ MAC (32:1). They were requested to administer the questionnaire to technicians on the list of primary respondents, or alternates if a primary respondent was unavailable. Instructions for the project officer included a request

that the questionnaire be administered in a monitored environment. Administration of the questionnaire as requested was accomplished at McChord AFB by having each of the respondents report to his respective squadron training unit to complete the questionnaire. However, this was not the case at McGuire AFB where individual questionnaires were sent to the respondent's work center and returned to the project officer when completed. This procedure is considered a minor limitation, because some collaboration of responses could have occurred at McGuire AFB.

The decision to use project officers to administer the questionnaire, instead of the researchers administering the questionnaire on-site, was made because of the limitations imposed by the academic environment and the lack of TDY funds. The use of project officers was not the most preferred approach due to the possible introduction of differences of interests in the study by personnel outside the academic environment. This difference of interests could lead to potential inaccuracies and procedural inconsistencies in the data collection process. This, in fact, occurred at McGuire AFB, where the questionnaire was not administered in a monitored environment as requested.

Upon receipt of the completed questionnaire from the project officers, individual question responses were input to a computer data base to facilitate computerized analyses. The data were grouped by respondent and summarized by question.

In addition to the data obtained from the survey questionnaire, the AFHRL questionnaire data base was also input to a computer data base.

Statistical Tests

Nonparametric tests were used to make all statistical tests because (1) nonparametric tests require no assumptions about the population distribution, and (2) all questions were of ordinal or nominal strength (38:116).

Chi square test: two independent samples. The chi square (χ^2) test for two independent samples was used to test statistical hypotheses based upon questions which provided only nominal data. This test was used to determine if there was a significant difference between the responses to the survey questionnaire and the AFHRL questionnaire. The alternate hypotheses generally stated

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that the two samples had different attitudes about some aspect of C-141A Job Guides.

To conduct this test, the data for each statistical hypothesis tested were placed in a contingency table. The table was made up of a column for each group, or sample, and a row for each category, or response. The actual number of responses for each response, for each group, was then placed in its appropriate cell. Responses were then totaled for each row and each column. The test statistic was then computed by the following formula:

$$\chi^2 = \sum_{i=1}^r \sum_{j=1}^k \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where:

O_{ij} = observed number of cases categorized in ith row of jth column

E_{ij} = number of cases expected under H_0 to be categorized in ith row of jth column

$\sum_{i=1}^r \sum_{j=1}^k$ = directs one to sum over all (r) rows and all (k) columns, i.e., to sum over all cells [38:104].

In the χ^2 test for two independent samples, k is always equal to 2. E_{ij} is computed for each cell by multiplying the two marginal response totals common to a particular cell and then dividing this product by the total

number of responses. If the differences between the observed frequencies and the expected frequencies for each cell are large, the value of χ^2 will be large. The computed distribution of χ^2 is approximated by a chi square distribution with a degrees of freedom = $(r-1)(k-1)$ (38:105).

The hypothesis was then tested at a .05 level of significance. The computed value of χ^2 (χ_o^2), with its associated degrees of freedom, was compared with the critical value of χ^2 (χ_c^2), with the same degrees of freedom, for a level of significance of .05. If $\chi_o^2 > \chi_c^2$ the null hypothesis was rejected and the conclusion drawn that a significant difference does exist in the attitudes of the two samples. The chi square test was conducted by using the computer program, Statistical Package for the Social Sciences (SPSS), sub-program CROSSTABS, and selecting the chi square option (6).

When using the χ^2 test and the degrees of freedom is larger than 1, no more than 20 percent of the cells can have an expected frequency of less than 5 and no cell can have an expected frequency of less than 1 (38:110).

"When this requirement is violated, the results of the test are meaningless [38:178]." For each χ^2 test conducted, the expected frequency was manually computed for each cell to insure that this restriction was met. None of the tests using the χ^2 two sample test, exceeded these restrictions, and it was not necessary to combine responses.

The χ^2 test was conducted as a one-tailed test which does not show the direction of differences (38:179). Thus, a visual inspection was made of the contingency table to see if any difference was in the predicted direction.

Chi square test: k-independent samples. The chi square test for k-independent samples was used to test statistical hypotheses based upon questions which provided only nominal data. This test was used to determine if there was a significant difference between the responses made by different grades to the questions selected for testing. The alternate hypotheses generally stated that the samples for each grade do not have the same attitudes about some aspect of C-141A Job Guides. The test for k-independent samples is an extension of the test for

two independent samples. "In general, the test is the same for both two and k-independent samples [38:175]." The only difference being that the number of columns (k) is greater than two.² The formula used for computing χ_o^2 was the same as that used for the χ^2 two-sample test. Again, the test was conducted by using the computer program SPSS, subprogram CROSSTABS, and selecting the chi square option (6).

The hypothesis was tested at a .05 level of significance. If $\chi_o^2 > \chi_c^2$ the null hypothesis was rejected and the conclusion drawn that a significant difference does exist in the attitudes of the different grades.

The same restrictions which apply to the χ^2 two independent sample test also apply to the χ^2 k-independent sample test (38:178). As for the two-sample test, the expected frequency for each cell was manually computed to insure that no more than 20 percent of the cells had expected frequencies less than five and none had an expected value of less than one. If these

²This is generally true. However, when χ^2 is computed for a 2 x 2 contingency table a different formula is required (38:107).

restrictions were not met, responses and/or grades were grouped together to meet this restriction and the test was conducted again. In all cases it was found necessary to combine E2s and E3s into one group; E6s, E7s, and E8s into another group; and WG 10s and WG 11s into a third group.

The χ^2 test of k-independent samples was conducted as a one-tailed test which does not show direction of differences (38:179). Thus, a visual inspection was made of the contingency table to see if any difference was in the predicted direction.

Mann-Whitney rank sum test. The Mann-Whitney Rank Sum Test was used to test the hypotheses based upon questions providing ordinal data.

When at least ordinal measurement has been achieved, the Mann-Whitney U test may be used to test whether two independent groups have been drawn from the same population. This is one of the most powerful of the nonparametric tests, and it is a most useful alternative to the parametric t test when the researcher wishes to avoid the t test's assumptions, or when the measurement in the research is weaker than interval scaling [38:116].

This test was used to determine if there was a significant difference between the distribution of responses to the survey questionnaire and the AFHRL questionnaire.

In comparing responses from the two questionnaires, the null hypothesis, H_0 , was that the two populations have the same distribution. The alternate directional hypothesis, H_A , was that the attitudes of technicians at bases which participated in the development and pre-implementation of testings of C-141A Job Guides have a more positive attitude about some aspect of job guides than the technicians at bases which did not participate. If "a" was one observation from the population sampled by the AFHRL questionnaire and "b" was one observation from the population to be sampled by the survey questionnaire, $H_0: p(a > b) \leq \frac{1}{2}$ and $H_A: p(a > b) > \frac{1}{2}$. A one-tailed test was used, since direction had been predicted. If the shift in the distribution was not in the predicted direction, a two-tailed test was used to test for significance. A two-tailed test was used in this case because there was no longer a-priori knowledge to serve as a basis for a directional hypothesis. In this case $H_A: p(a > b) \neq \frac{1}{2}$ (38:116).

When applying the Mann-Whitney test, n_1 was equal to the number of observations in the larger of the two independent samples, and n_2 was equal to the number of observations in the smaller. The observations from

both samples were combined and ranked in order of increasing size and W was the sum of the ranks of the smaller sample (38:116). In applying this test to this study, increasing size means that the most positive response for a question is the smallest size, i.e., receives the lowest ranking. The Mann-Whitney test assumes that the measured observations are independent and represent a distribution which has underlying continuity. With exact measurement of a variable having underlying continuity, the probability of a tie is zero. Therefore, to use the Mann-Whitney test it was assumed that the attitudes of respondents (to either sample) who selected a given response were really different, but that the questions were not precise enough to measure this difference. Thus, the ranking assigned to all the observations for each response to a question was the average of the ranks they would receive if no ties occurred (38:123-124).

In cases when the larger of the two samples (n_1) is greater than 20, the sampling distribution employed in the Mann-Whitney test approaches the normal distribution (38:120-121). In this case the computed value of Z is computed by the following general formula:

$$Z = \frac{[W - E(W)]}{SD_W}$$

and:

$$E(W) = \frac{1}{2}n_2(n_1 + n_2 + 1)$$

and:

$$SD_W = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}$$

where:

W is the actual sum of the ranks assigned to the observations in the smaller sample

E(W) is the expected value of W

SD_W is the standard deviation of E(W) (43:1)

However, this general formula does not correct for ties. If ties occur between two or more observations involving both samples, the value of W is affected and a correction for ties should be employed (38:124). As all tests made during this study involved ties, the following correction factor was substituted into the general formula:

$$SD_W = \sqrt{\left(\frac{n_1 n_2}{N(N-1)}\right) \left(\frac{N^3 - N}{12} - \sum T\right)}$$

where:

$$N = n_1 + n_2$$

$$T = \frac{t^3 - t}{12} \quad (\text{where } t \text{ is the number of observations tied for a given response, i.e., in this case } t \text{ is the number of observations for each response on the question being tested}).$$

and:

$\sum T$ is found by summing the T s over all groups of tied observations, i.e., in this case summing the T s for each response (38:124).

In order to simplify the calculations for the Mann-Whitney Rank Sum Test, a FORTRAN computer program was constructed to process the summarized survey data. This program was a modification of the program developed by Ashbaugh and Godfrey (5:App E). Changes were made to this program to allow for a different number responses on the questions tested and to correct for ties. A copy of the revised program used is shown in Appendix G.

Kruskal-Wallis one-way analysis of variance by ranks.

When at least ordinal measurement is achieved, the Kruskal-Wallis one-way analysis of variance by rank is an extremely useful test for deciding whether k -independent samples are from different populations (38:184).

The Kruskal-Wallis test seems to be the most efficient of the non-parametric tests for k independent samples. It has power-efficiency of $3/\pi = 95.5$ per cent, when compared with the F test, the most powerful parametric test [38:194].

The Kruskal-Wallis one-way analysis of variance by rank was used to test statistical hypotheses about differences of attitudes between pay grades which were based upon questions providing ordinal data. This test was used to determine if there was a statistically significant difference between the distribution of responses to the questions selected for testing for each grade. This test does not show the direction of the differences. Thus, a visual inspection of the average rank assigned to each grade was made to determine if the differences were in the predicted direction. In comparing responses by the grade of the respondents, the null hypothesis, H_0 , was that the sample for each pay grade comes from the same or identical populations with respect to their attitudes about C-141A Job Guides. The alternate directional hypothesis, H_A , generally stated that lower grade technicians have a more positive attitude about some aspect of C-141A Job Guides than do higher grade technicians.

In the computation of the Kruskal-Wallis test, each observation is ranked and placed in a single series. This procedure is similar to that used in assigning ranks in the Mann-Whitney test, the only difference

being that ranks are assigned across k samples instead of just two samples. The Kruskal-Wallis test also assumes that the observations are independent and represent a distribution which has underlying continuity (38:185). With exact measurement of a variable having underlying continuity, the probability of a tie is zero. Therefore, in order to use the Kruskal-Wallis test, it was assumed that the attitude of each respondent who selected a given response to a question was really different, but that the question was not precise enough to measure this difference. Consequently, all observations for a given response were summed and treated as a tie. When each observation had been assigned a rank, the sum of the ranks for each grade was found and used to find H.

The following formula was used to compute H:

$$H = \left[\frac{12}{N(N+1)} \sum_{j=1}^k \frac{R_j^2}{n_j} \right] - 3(N+1)$$

where:

k = number of samples, i.e., grades

n_j = number of observations in the jth sample, i.e., the total number of responses made by respondents of a given grade

$N = n_j$, the total number of observations,
i.e., the total number of responses
made by respondents of all grades

R_j = sum of the ranks in jth sample, i.e.,
grade

$\sum_{j=1}^k$ directs one to sum over the k samples,
i.e., grades (38:185).

The above formula does not correct for ties.
Because the application of the Kruskal-Wallis test in
this study involved almost exclusively tied observations,
a correction factor for ties was used. The value of H
computed by the above formula was divided by the correc-
tion factor to obtain a value for H corrected for ties.
The correction factor was obtained by use of the follow-
ing formula:

$$1 - \frac{\sum T}{N^3 - N}$$

where:

$T = t^3 - t$ (when t is the number of respon-
dents of all grades who selected
a given response)

N = the total number of responses made by
respondents of all grades

$\sum T$ = directs one to sum over all responses
(38:188).

This corrected value of H is distributed as a chi square with $k-1$ degrees of freedom, where k is the number of different grades which were tested. If this value of H was equal to or larger than the critical value of H with $k-1$ degrees of freedom and for the previously set level of significance, the H_0 was rejected (38:185). The hypotheses were tested at a .05 level of significance.

In order for the corrected value of H to follow a chi square distribution, each of the grades must have at least five respondents (38:185). In cases where the number of responses made by a given grade was less than five the responses made by that grade were combined with those of the closest appropriate grade in order to meet the above restrictions. It was necessary to combine responses for E2s and E3s and also for E7s and E8s for all hypotheses tested.

In order to simplify the calculations involved in testing the hypotheses via the Kruskal-Wallis test, the data were input into a computer. The data were then processed using SPSS, subprogram NPAR (42:30).

Criteria tests. In addition to the statistical tests applied to the applicable statistical hypotheses,

practical decision rules were also required. These rules, or criteria tests, were used to determine if the results of the data analysis were of practical importance in meeting the research objectives.

The decision rules were formulated by discussing each of the research hypotheses with a panel of experts. The members of the panel were asked how many statistical hypotheses they thought should be significant for each research hypothesis before that research hypothesis could be accepted. They were also asked, for each research hypothesis, what related statistical hypotheses, if any, must be found significant before the associated research hypotheses could be accepted (24,39).

The members of the panel of experts were Robert C. Johnson and Donald L. Thomas, both of whom are research psychologists working for AFHRL/ASR. They were selected for their intimate knowledge of the C-141A Job Guides and their prior experience in measuring technicians' attitudes about C-141A Job Guides.

The following decision rules were formulated from the common areas of agreement among the panel of experts.

Research Hypothesis 1 states that technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides have a higher degree of acceptance of the job guides than do technicians at bases which did not participate in the development and pre-implementation testing. Support or non-support of this research hypothesis was provided by five statistical hypotheses (H_1 through H_3). A finding of statistical significance in the predicted direction for H_1 and H_2 was considered essential for the support of Research Hypothesis 1. H_{2a} and H_{2b} were considered to be subsets of H_2 . They are important only to the extent that they help explain the results obtained in H_2 .

Research Hypothesis 2 states that technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides perceive the job guides to be more usable than do technicians at bases which did not participate in the development and pre-implementation testing. Support or non-support for this research hypothesis was provided by five statistical hypotheses (H_3 through H_7). A finding of statistical significance in the predicted direction for H_4 was considered essential for the support of Research Hypothesis

2. In addition, any two of the other four statistical hypotheses must have been found statistically significant and in the predicted direction before Research Hypothesis 2 was accepted.

Research Hypothesis 3 states that lower grade technicians have a higher degree of acceptance for the C-141A Job Guides than do higher grade technicians. Support or non-support of this research hypothesis was provided by five statistical hypotheses (H_7 through H_{10}). A finding of statistical significance in the predicted direction for H_8 and H_9 was considered essential for the support of Research Hypothesis 3. H_{9a} and H_{9b} were considered to be subsets of H_9 . They are important only to the extent that they help explain the results obtained in H_9 .

Research Hypothesis 4 states that lower grade technicians perceive the C-141A Job Guides to be more usable than do higher grade technicians. Support or non-support of this research hypothesis was provided by five statistical hypotheses (H_{10} through H_{14}). A finding of statistical significance in the predicted direction for H_{11} was considered essential for the support of Research Hypothesis 4. In addition, any two of the

other four statistical hypotheses must have been found statistically significant and in the predicted direction before Research Hypothesis 4 was accepted.

Assumptions

The following is a summary list of assumptions made in this study.

1. That the AFHRL sample was representative of the population at Charleston AFB and Norton AFB, and that the two data bases (this one and AFHRL's) could be compared without limitation in terms of the distribution of responses to individual questions.
2. That the attitudes of respondents, to either the survey questionnaire or the AFHRL questionnaire, who selected a given response were really different, but the questions were not precise enough to measure this difference.
3. That during the AFHRL survey all respondents had some knowledge of the old C-141A TOs, at least in ATC training, if not in actual on-the-job use.
4. That not all respondents to the current survey had some knowledge of the old C-141A TOs.
5. That the additional instruction placed before question 26 in the survey questionnaire provided more

comparable data with AFHRL data by allowing recent entries into the career field to skip questions 26 to 30 rather than ask them to choose a response for which they had no basis to answer.

6. That respondents saw that the responses to question 9 were rank ordered and response c was better than response d, but not as good as response b, even if they were not familiar with the old C-141A TOs.

7. That the change in wording to question 33 did not invalidate the comparison of the responses to this question with responses obtained by AFHRL.

Limitations

The following is a summary list of limitations of this study:

1. Explanation of any significant differences between this sample and the AFHRL sample was restricted to an analysis of questionnaire responses because no on-site interviews or task observations were made.

2. The population of interest did not include all personnel involved in C-141A maintenance. This precluded generalization of the results of this survey beyond the population of interest.

3. Some collaboration of responses may have occurred at McGuire AFB because the questionnaire was not administered in a monitored environment.

Chapter 4

DATA ANALYSIS AND DISCUSSION

Introduction

This chapter describes the analysis of the data collected in this research and answers the research hypotheses and statistical hypotheses formulated to satisfy the research objectives listed in Chapter 1.

Questionnaire data. There were a total of 320 questionnaires sent to project officers at McChord and McGuire AFBs during May, 1977. There were 273 completed questionnaires returned for a response rate of 85.31 percent. The large number of primary respondents who were on leave, TDY, or departed PCS, together with the relatively small size of the alternate list, prevented the return of 100 percent of the questionnaires. Three of the completed questionnaires were unusable and one was eliminated because the respondent first received exposure to job guides at Charleston AFB. The remaining 269 completed questionnaires provided a confidence/reliability level greater than 94 percent, but less than 95 percent. A complete summary of the questionnaire responses is shown in Appendix C.

In recording the data from individual questionnaires, the responses to two questions were edited. Questions 47 and 48 asked respondents what most influenced their preference for job guides and the old C-141A TOs, respectively. Respondents were instructed to answer either question, but not both. Additionally, respondents who had no preference, or had not used the old C-141A TOs, were instructed to skip both questions. Accordingly, when respondents answered both questions their responses to both questions were recorded as "w", "answered both questions 47 and 48." Also, when respondents indicated that they had no knowledge of the old C-141A TOs by not answering questions 26 to 30, their response to question 47 or 48 was recorded as "x", "did not answer questions 26 to 30."

Two additional edits were performed in recording questionnaire responses for all questions. First, when a respondent selected more than one response to a question or wrote in his own response, a "y", "other or multiple response" was recorded. Second, in those cases where a respondent did not mark a response to a question, a "z", "no response" was recorded.

A summary of the proportions of current survey respondents, by demographic variable, compared to the

proportions obtained in the AFHRL survey and the population proportions from which the current survey was drawn is shown in Appendix H.

The proportion of civilians in the current survey is greater than the proportion of civilians in the population from which the survey was drawn. This was done by design in order to make the current survey sample more comparable to the AFHRL sample. Similarly, the proportion of respondents by type of squadron to which assigned does not compare to the current survey population proportions. This was also done by design in order to make the current survey sample more comparable to the AFHRL sample.

Presentation format. The presentation of the data analysis will be by research hypotheses and statistical hypotheses in the same order as presented in Chapter 1. Each research hypothesis and statistical hypothesis will be restated along with the applicable survey question. The findings for each statistical hypothesis will be presented in three parts according to the following format:

a. Movement: Since all the hypotheses predict direction, the results of this prediction will be

presented to indicate if the data results were actually in the predicted direction.

b. Significance: The results of the statistical test will be presented to show if the test was statistically significant.

c. Support: The results of the statistical test will be related to the applicable research hypothesis, to show if the statistical hypothesis does in fact lend support to the research hypothesis.

A table will be presented to show the data collected for each statistical test. In the statistical hypotheses dealing with differences between pay grades it was necessary to group several grades to meet test restrictions. In these cases data will be displayed as they were grouped. The computed test statistic will be shown, as will the level of significance (p). Where applicable, the associated degrees of freedom (d.f.) will also be shown.

Finally, comments will be made concerning the general findings of the test. In cases where the various pay grades were grouped to meet test restrictions the comments regarding trends apply to the grouped pay grades and not to individual pay grades.

Analysis

Research Hypothesis 1 (H_1 through H_3)

Technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides have a higher degree of acceptance of the job guides than do technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 1

Technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides like the new job guides better than do technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 9. How do you like the Job Guide Manuals?

- a. They are completely satisfactory
- b. They are good, but could be improved
- c. They are satisfactory, but no better than the old TOs
- d. They are unsatisfactory

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 1

Responses to Question 9 By Survey
(Mann-Whitney Rank Sum Test)

Survey	Response			
	a	b	c	d
AFHRL (N = 311)	30	217	46	18
Current (N = 264)	24	169	44	27
Total (N = 575)	54	386	90	45

Computed $Z = 1.664$; $.0475 < p < .0485$.

3. Comments

The responses to this question were favorable in both the AFHRL and current survey. However, the responses in the current survey were, as predicted, not quite as favorable as those in the AFHRL survey. Seventy-nine percent of the AFHRL survey found JGMs "completely satisfactory" or "good, but could be improved" compared to 73 percent of the current survey. Only six percent of the AFHRL survey found JGMs "unsatisfactory" compared to ten percent of the current survey.

Statistical Hypothesis 2

A greater proportion of the technicians at bases which participated in the development and

pre-implementation testing of the C-141A Job Guides prefer job guides over other styles of technical data than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 20. Would you prefer to use

- a. Traditional-style TOs
- b. Job guide-style TOs
- c. Checklists
- d. No TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 2

Responses to Question 20 By Survey
(χ^2 Two Sample Test)

Survey	Response			
	a	b	c	d
AFHRL (N = 305)	63	168	55	19
Current (N = 267)	64	120	72	11
Total (N = 572)	127	288	127	30

Computed $\chi^2 = 9.936$; d.f. = 3; p = .0191.

3. Comments

Fifty-five percent of the AFHRL survey preferred to use job guide style TOs over other types of technical data, compared to 45 percent of the current survey. The second most preferred type of technical data of the AFHRL survey was traditional style TOs, which was selected by 21 percent of the respondents. The second most preferred type of technical data of the survey was checklists, which was selected by 27 percent of the respondents. The least preferred of both samples was "no TOs."

Statistical Hypothesis 2a

A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides prefer JGMs over other styles of technical data for routine jobs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 36. Which type of technical data would you prefer to use for routine jobs?

- a. Traditional TO
- b. Checklist
- c. Job Guide Manuals
- d. Very general procedures

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 3

Responses to Question 36 By Survey
(χ^2 Two Sample Test)

Survey	Response			
	a	b	c	d
AFHRL (N = 296)	41	105	116	34
Current (N = 266)	36	114	80	36
Total (N = 562)	77	219	196	70

Computed $\chi^2 = 5.779$; d.f. = 3; p = .1229.

3. Comments

No statistical significance was found between the two surveys on the responses to this question. However, the AFHRL respondents preferred JGMs over checklists by 39 percent to 35 percent for routine jobs. While the current survey respondents preferred checklists over JGMs by 43 to 30 percent. Only about 13 percent of the respondents from each survey preferred traditional TOs for routine maintenance.

Statistical Hypothesis 2b

A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides prefer JGMs over other styles of technical data for non-routine jobs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 37. Which type of technical data would you prefer to use for non-routine jobs?

- a. Traditional TO
- b. Checklist
- c. Job Guide Manuals
- d. Very general instructions

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 4
Responses to Question 37 By Survey
(χ^2 Two Sample Test)

Survey	Response			
	a	b	c	d
AFHRL (N = 302)	70	32	182	18
Current (N = 267)	92	33	122	20
Total (N = 569)	162	65	304	38

Computed $\chi^2 = 12.846$; d.f. = 3; p = .0050.

3. Comments

Sixty percent of the AFHRL survey preferred JGMs for non-routine jobs. Traditional TOs were a distant second which were preferred by only 23 percent of the AFHRL respondents. JGMs were also the most preferred by the current survey. However, they were only preferred by 46 percent to 35 percent over traditional TOs. Traditional TOs received a higher rating from both surveys for non-routine jobs than they did for routine jobs.

Statistical Hypothesis 3

A greater proportion of the technicians at bases which participated in the development and

pre-implementation testing of the C-141A Job Guides feel that they use JGMs more than the old TOs than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 27. One of the goals of the JG program is to provide better tech data to encourage use on the job. Do you feel that:

- a. You use JGMs more than the TOs
- b. About the same as the old TOs
- c. Less than the old TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 5

Responses to Question 27 By Survey
(Mann-Whitney Rank Sum Test)

Survey	Response		
	a	b	c
AFHRL (N = 310)	111	151	48
Current (N = 212)	70	106	36
Total (N = 522)	181	257	84

Computed Z = .705; .2389 < p < .2420.

3. Comments

The majority of respondents from both surveys indicated that they used JGMs about the same as the old TOs. However, this question could be misleading, resulting in a measure of something other than acceptance. For example, a respondent may actually prefer JGMs over TOs; however, since he previously used the old TOs all the time and now uses JGMs all the time he might respond that he used JGMs "about the same as the old TOs."

Conclusion

The results of testing H_1 through H_3 (summarized in Table 6) provided support for acceptance of Research Hypothesis 1. The respondents to the AFHRL survey had a more favorable attitude toward job guides than did the respondents to the current survey. H_1 and H_2 were found to be statistically significant in the predicted direction which satisfies the criteria tests established in Chapter 3.

While H_3 was not found to be statistically significant, the movement was in the predicted direction. As stated earlier, question 27, upon which H_3 was based, could be measuring something other than acceptance of JGMs. This may explain why no statistical significance

Table 6

Research Hypothesis 1: Hypothesis Test Results

<u>Hypothesis Number</u>	<u>Question Number</u>	<u>Movement¹</u>	<u>Significance</u>	<u>Probability</u>	<u>Support</u>
1	9	+	Yes	.0475 < p < .0485	Yes
2	20	+	Yes	p = .0191	Yes
2a	36	+	No	p = .1229	No
2b	37	+	Yes	p = .0050	Yes
3	27	+	No	.2389 < p < .2420	No

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¹ + means movement is in the predicted direction, Ø means direction of movement cannot be determined, and - means movement is not in the predicted direction.

was found for this hypothesis. However, this rationale is purely conjectural.

H_{2a} and H_{2b} were established to help explain any significant findings to H_2 . Examination of H_{2a} and H_{2b} revealed that the major difference between the two surveys was in the use of JGMs for non-routine maintenance. Sixty percent of the AFHRL respondents preferred JGMs for non-routine maintenance, while only 46 percent of the current survey respondents preferred JGMs for non-routine maintenance.

A comparison between the two surveys of all the questions classified as acceptance questions was also performed. The results of this analysis are contained in Appendix I. Of the 16 questions classified as questions measuring acceptance, nine were found to be statistically significant in the predicted direction. Movement was in the predicted direction in five of the remaining seven which were not statistically significant. These findings provide additional support for accepting Research Hypothesis 1.

Even though Research Hypothesis 1 was not rejected, acceptance of job guides as measured by the current survey was favorable. User acceptance of C-141A Job

Guides was found to be high and generally only a few percentage points less favorable than that found by AFHRL. Thus, the findings of the current survey basically support the favorable user acceptance of C-141A Job Guides as found by the AFHRL survey.

Research Hypothesis 2 (H_2 through H_7)

Technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides perceive the job guides to be more usable than do technicians at bases which did not participate in the development and pre-implementation testing.

Statistical Hypothesis 3

This hypothesis is the same as H_2 under Research Hypothesis 1. The same findings and comments made beginning on page 108 apply.

Statistical Hypothesis 4

A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that JGMs are a better source of information for their jobs than the old TOs than does the proportion of the technicians at the bases which did not participate in the development and pre-implementation testing.

1. Survey Question 26. As a source of information for your job, the new job guide manuals are:

- a. Much better than the old TOs
- b. Better than the old TOs, but can be improved. Require refinement.
- c. No better than the old TOs
- d. Worse than the old TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significant: Is not statistically significant
- (c) Support: Does not offer practical support

Table 7

Responses to Question 26 By Survey
(Mann-Whitney Rank Sum Test)

Survey	Response			
	a	b	c	d
AFHRL (N = 311)	44	174	58	35
Current (N = 211)	35	102	39	35
Total (N = 522)	79	276	97	70

Computed Z = .792; $.2119 < p < .2148$.

3. Comments

No statistical significance was found between the two surveys on the responses to this question. Sixty percent of the AFHRL respondents and 55 percent of the

current survey respondents felt that JGMs were "better" or "much better" than the old C-141A TOs. Only 11 percent of the AFHRL respondents and 16 percent of the current survey respondents indicated that JGMs were worse than the old C-141A TOs.

Statistical Hypothesis 5

A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that job guides are more valuable for on-the-job training (OJT) than the old TOs than does the proportion of the technicians at the bases which did not participate in the development and pre-implementation testing.

1. Survey Question 28. How valuable do you think the job guides are to OJT?

- a. Valuable--much better than the old TOs
- b. Valuable--about the same as the old TOs
- c. Of little value--about the same as the old TOs
- d. Of no value--much worse than the old TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 8
Responses to Question 28 By Survey
(Mann-Whitney Rank Sum Test)

Survey	Response			
	a	b	c	d
AFHRL (N = 310)	157	96	41	16
Current (N = 210)	92	73	30	15
Total (N = 520)	249	169	71	31

Computed Z = 1.528; .0630 < p < .0643.

3. Comments

No statistical significance was found between the two surveys on the responses to this question. Eighty-two percent of the AFHRL respondents and 79 percent of the current survey respondents indicated that job guides were valuable for OJT. Fifty-one percent of the AFHRL respondents and 44 percent of the current survey respondents felt that job guides were more valuable for OJT than the old C-141A TOs. Surprisingly, a number of current survey respondents wrote in that one of the best features of job guides was that they were good for OJT. Only five percent of the AFHRL respondents and seven percent of the current survey respondents

indicated that job guides were much worse than the old TOs for OJT.

Statistical Hypothesis 6

A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that JGMs and ITTAs will help them do their job better than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 33. Do you think that the new job guide manuals and troubleshooting aids have helped (or will help) you do your job?

- a. Better
- b. About the same
- c. Not as well

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 9
Responses to Question 33 By Survey
(Mann-Whitney Rank Sum Test)

Survey		Response		
		a	b	c
AFHRL	(N = 309)	145	149	15
Current	(N = 264)	111	121	32
Total	(N = 573)	256	270	47

Computed Z = 1.955; .0250 < p < .0256.

3. Comments

Forty-seven percent of the AFHRL respondents and 42 percent of the current survey respondents indicated that JGMs would help them do their job better. Conversely, only five percent of the AFHRL respondents and 12 percent of the current survey respondents indicated that JGMs would help them do their job "not as well." As anticipated in Appendix E, paragraph 10, page 218 there was some confusion on this question. A few respondents wrote in "compared to what?" However, it was felt that the comparison of responses to this question with those obtained by AFHRL was still valid since the same confusion existed on the AFHRL questionnaire.

Statistical Hypothesis 7

A greater proportion of the technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides feel that LTTAs require less time to troubleshoot than does the proportion of the technicians at bases which did not participate in the development and pre-implementation testing.

1. Survey Question 44. Do LTTAs require more or less time to troubleshoot a problem?

- a. Less time is required using LTTAs
- b. About the same amount of time
- c. More time is required when using LTTAs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 10

Responses to Question 44 By Survey
(Mann-Whitney Rank Sum Test)

Survey	Response		
	a	b	c
AFHRL (N = 143)	38	60	45
Current (N = 110)	17	51	41
Total (N = 253)	55	111	86

Computed $Z = 1.760$; $p = .0392$.

3. Comments

Responses to this question were not as favorable as responses to other questions. Twenty-seven percent of the AFHRL respondents and 16 percent of the current survey respondents indicated that less time to troubleshoot a problem was required using LTTAs. On the other hand, 32 percent of the AFHRL respondents and 37 percent of the current survey respondents felt that more time was required to troubleshoot a problem using LTTAs.

In an attempt to explain the less favorable responses to this question, the responses on the current survey to question 41 and 44 were compared. Question 41

asks respondents how frequently they use LTTAs. A statistically significant relationship ($p = .0014$) between the two questions was found. Of those respondents who indicated that they use LTTAs for all troubleshooting tasks, 38 percent replied that less time was required to troubleshoot a problem using LTTAs; 54 percent felt about the same amount of time was required; and only eight percent replied that more time was required when using LTTAs. Conversely, of those respondents who indicated that they do not use LTTAs at all, none felt that less time was required to troubleshoot a problem using LTTAs; 27 percent felt that about the same amount of time was required using LTTAs, and 73 percent indicated that more time was required when using LTTAs. Clearly those respondents who frequently use LTTAs had a more favorable attitude about how much time was required to troubleshoot a problem using LTTAs. However, it is not clear whether this more favorable attitude was the cause or the effect of their more frequent use of LTTAs.

Conclusion

The results of testing H_3 through H_7 (summarized in Table 11) did not provide adequate support to accept

Table 11
Research Hypothesis 2: Hypothesis Test Results

<u>Hypothesis Number</u>	<u>Question Number</u>	<u>Movement¹</u>	<u>Significance</u>	<u>Probability</u>	<u>Support</u>
3	27	+	No	.2389 < p < .2420	No
4	26	+	No	.2119 < p < .2148	No
5	28	+	No	.0630 < p < .0643	No
6	33	+	Yes	.0250 < p < .0256	Yes
7	44	+	Yes	p = .0392	Yes

¹ + means movement is in the predicted direction, Ø means direction of movement cannot be determined, and - means movement is not in the predicted direction.

Research Hypothesis 2. The criteria tests required that H_4 plus any two of the other four statistical hypotheses be statistically significant in the predicted direction. While the movement in all cases was in the predicted direction, it was only statistically significant for H_6 and H_7 .

A comparison between the two surveys of all the questions classified as usability questions was also performed. The results of this analysis are contained in Appendix I. Of the 18 questions classified as questions measuring usability, eight were found to be statistically significant; seven in the predicted direction and one in the opposite direction. Of the remaining ten questions measuring usability, movement in six of them was in the predicted direction, while movement in the other four was in the opposite direction. These findings are consistent with the results of testing H_3 through H_7 and support the rejection of Research Hypothesis 2.

The perceived usability of C-141A Job Guides by technicians was found to be generally very favorable. Thus, the findings of the current survey are basically consistent with AFHRL's findings with regards to perceived usability of C-141A Job Guides.

Research Hypothesis 3 (H_8 through H_{10})

Lower grade technicians have a higher degree of acceptance of the job guides than do higher grade technicians.

Statistical Hypothesis 8

Lower grade technicians like the new job guides better than do higher grade technicians.

1. Survey Question 9. How do you like the Job Guide Manuals?

- a. They are completely satisfactory
- b. They are good, but could be improved
- c. They are satisfactory, but not better than the old TOs
- d. They are unsatisfactory

2. Findings

- (a) Movement: Direction cannot be determined
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 12
Responses to Question 9 By Grade
(Kruskal-Wallis One-Way ANOVA)

Pay Grade	Response			
	a	b	c	d
E2 and E3 (N = 59)	5	46	6	2
E4 (N = 69)	5	41	12	11
E5 (N = 49)	9	27	7	6
E6 (N = 19)	0	12	6	1
E7 and E8 (N = 14)	0	10	2	2
WG 10 (N = 25)	1	18	4	2
WG 11 (N = 28)	4	14	7	3
Total (N = 263)	24	268	44	27

Computed $\chi^2 = 8.2223$; d.f. = 6; p = .2223.

3. Comments

No statistical significance was found between the responses to this question when they were compared by pay grade of the respondents. As indicated in Figure 2, the proportion of respondents for each pay grade who felt that JGMs were "completely satisfactory" or "good but could be improved" showed no clear trend.

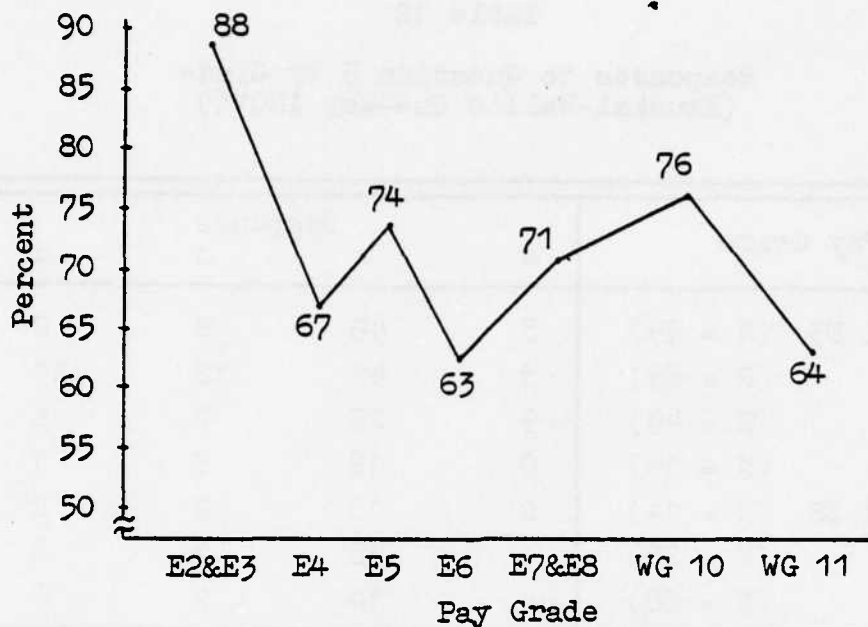


Figure 2

Percent of Respondents by Grade Who Felt that JGMs were "Completely Satisfactory" or "Good but Could be Improved"

Statistical Hypothesis 9

A greater proportion of lower grade technicians prefer job guides over other styles of technical data than does the proportion of higher grade technicians.

1. Survey Question 20. Would you prefer to use
 - a. Traditional-style TOs
 - b. Job guide-style TOs
 - c. Checklists
 - d. No TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is Statistically significant
- (c) Support: Does offer practical support

Table 13

Responses to Question 20 By Grade
(χ^2 k Sample Test)

Pay Grade		Response			
		a	b	c	d
E2 and E3	(N = 61)	5	36	17	3
E4	(N = 71)	16	31	22	2
E5	(N = 48)	13	18	13	4
E6, E7, and E8	(N = 33)	9	17	7	0
WG 10 and WG 11	(N = 53)	21	18	12	2
Total	(N = 266)	64	120	71	11

Computed $\chi^2 = 22.1695$; d.f. = 12; p = .0357.

3. Comments

The proportion of respondents for each pay grade who preferred to use Job-Guide style TOs generally decreased as grade increased. However, this trend was reversed for pay grade E6 through E8 (see Figure 3). One possible reason that this trend reversed for grades

E6 through E8 is because these higher grades may generally be more involved with management instead of the daily use of job guides and thus feel less threatened, as discussed on page 38 , by the change to job guides.

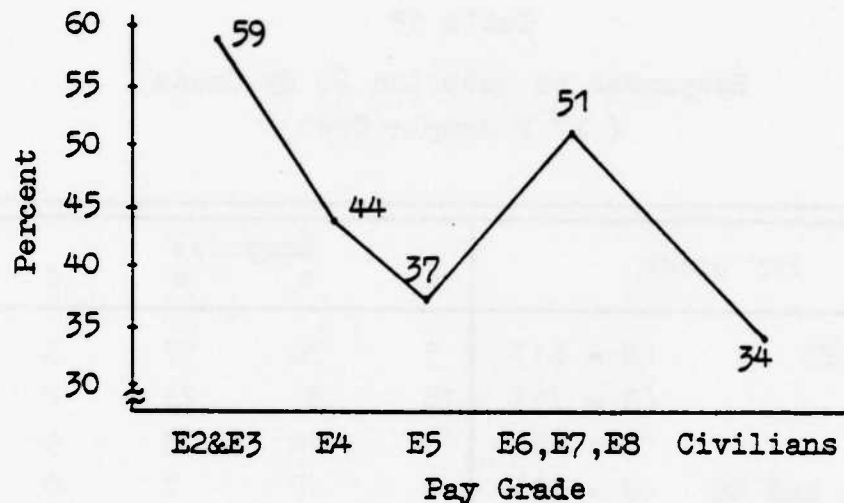


Figure 3

Percent of Respondents by Grade Who Prefer to Use Job Guide-Style TOs

Question 20 was originally tested for differences between grades using the groupings shown in Table 13. This does not meet the cell size restrictions discussed in Chapter 3. Thus, c and d responses were combined making a total of only three possible responses: traditional-style TOs, job guide-style TOs, and other. The χ^2 test was conducted again using these three

responses. The results showed that a statistical difference ($p = .0145$) still existed between pay grades.

Statistical Hypothesis 9a

A greater proportion of lower grade technicians prefer JGMs over other styles of technical data for routine jobs than does the proportion of higher grade technicians.

1. Survey Question 36. Which type of technical data would you prefer to use for routine jobs?

- a. Traditional TO
- b. Checklist
- c. Job Guide Manuals
- d. Very general procedures

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 14
Responses to Question 36 By Grade
(χ^2 k Sample Test)

Pay Grade		Response			
		a	b	c	d
E2 and E3	(N = 61)	3	28	25	5
E4	(N = 70)	7	33	22	8
E5	(N = 49)	7	19	14	9
E6, E7, and E8	(N = 31)	4	15	6	6
WG 10 and WG 11	(N = 54)	15	19	12	8
Total	(N = 265)	36	114	79	36

Computed $\chi^2 = 21.657$; d.f. = 12; p = .0415.

3. Comments

A statistical significance was found between the responses to question 36 when they were compared to the pay grade of the respondents. The proportion of respondents for each pay grade who preferred to use JGMs for routine maintenance showed a decreasing trend as grade increased (see Figure 4). Conversely the proportion of respondents for each pay grade who preferred to use traditional TOs increased with each higher grade. The largest proportion, when considering all pay grades, however, preferred to use checklists for routine jobs.

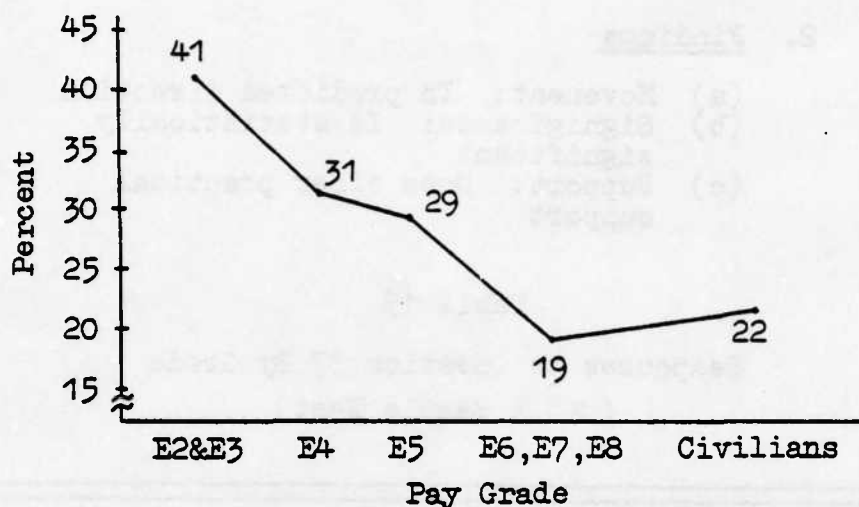


Figure 4

Percent of Respondents by Grade Who Prefer to Use JGMs for Routine Jobs

Statistical Hypothesis 9b

A greater proportion of lower grade technicians prefer JGMs over other styles of technical data for non-routine jobs than does the proportion of higher grade technicians.

1. Survey Question 37. Which type of technical data would you prefer to use for non-routine jobs?

- a. Traditional TO
- b. Checklist
- c. Job Guide Manuals
- d. Very general instructions

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 15

Responses to Question 37 By Grade
(χ^2 k Sample Test)

Pay Grade		Response			
		a	b	c	d
E2 and E3	(N = 60)	11	7	40	2
E4	(N = 71)	26	13	25	7
E5	(N = 49)	21	2	21	5
E6, E7, and E8	(N = 32)	12	4	16	0
WG 10 and WG 11	(N = 54)	22	6	20	6
Total	(N = 266)	92	32	122	20

Computed $\chi^2 = 25.527$; d.f. = 12; p = .0125.

3. Comments

The proportion of the respondents for each pay grade who preferred to use JGMs for non-routine jobs showed no clear trend (see Figure 5). However, the proportion of respondents for each pay grade who preferred to use traditional TOs generally increased as the pay grade increased.

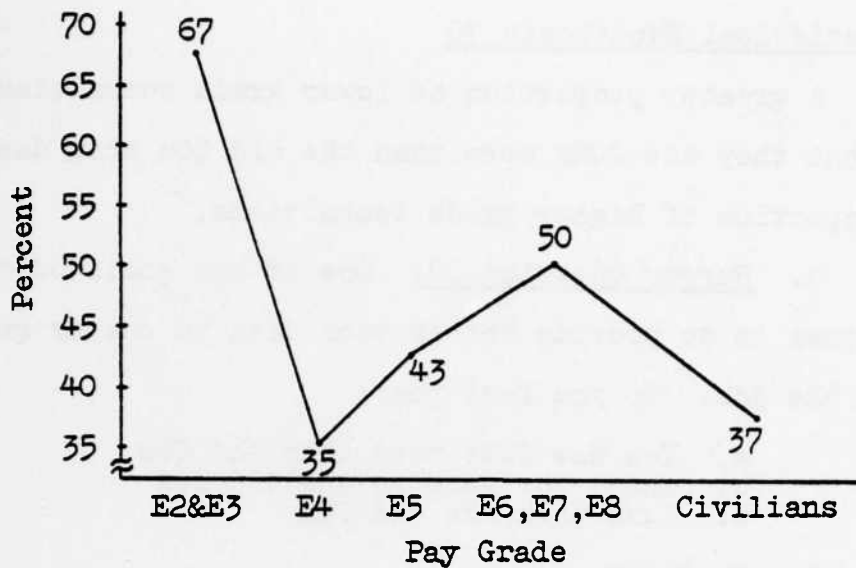


Figure 5

Percent of Respondents by Grade Who Prefer to Use JGMs for Non-routine Jobs

Question 37 was originally tested for differences between grades using the groupings shown in Table 15. This does not meet the cell size restriction discussed in Chapter 3. Thus, b and d responses were combined making a total of only three possible responses: Traditional TO, Job Guide Manuals, and other. The χ^2 test was conducted again using these three responses. The results showed that a statistical difference ($p = .0107$) still existed between pay grades.

Statistical Hypothesis 10

A greater proportion of lower grade technicians feel that they use JGMs more than the old TOs than does the proportion of higher grade technicians.

1. Survey Question 27. One of the goals of the JG program is to provide better tech data to encourage use on the job. Do you feel that:

- a. You use JGMs more than the TOs
- b. About the same as the old TOs
- c. Less than the old TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 16
Responses to Question 27 By Grade
(Kruskal-Wallis One-Way ANOVA)

Pay Grade	Response		
	a	b	c
E2 and E3 (N = 28)	11	12	5
E4 (N = 64)	24	31	9
E5 (N = 39)	13	18	8
E6 (N = 15)	7	7	1
E7 and E8 (N = 13)	5	4	4
WG 10 (N = 25)	5	17	3
WG 11 (N = 27)	5	16	6
Total (N = 211)	70	105	36

Computed $\chi^2 = 5.7154$; d.f. = 6; p = .4558.

3. Comments

No statistical significance was found between the responses to question 27 when they were compared by pay grade of the respondents. The proportion of respondents who felt that they used JGMs more than the old TOs generally decreased as grade increased. However, this trend was reversed for pay grades E6 to E8 (see Figure 6). Surprisingly, E6s had the highest proportion (47 percent) of respondents who felt that they used JGMs more than the old TOs. As pointed out earlier, this question could measure other things besides acceptance.

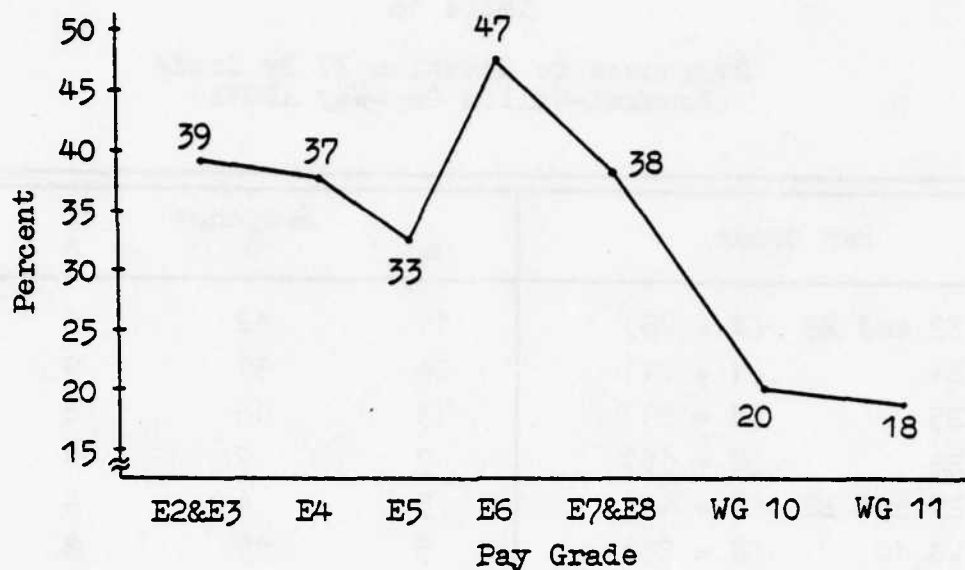


Figure 6

Percent of Respondents by Grade Who Felt That They
Used JGMs More Than the Old TOs

Conclusion

The results of testing H_8 through H_{10} , which are summarized in Table 17, did not provide adequate support to accept Research Hypothesis 3. The criteria tests established in Chapter 3 required that H_8 and H_9 be found statistically significant in the predicted direction. No statistical significance was found in H_8 or could the direction of any movement be determined.

Table 17
Research Hypothesis 3: Hypothesis Test Results

<u>Hypothesis Number</u>	<u>Question Number</u>	<u>Movement¹</u>	<u>Significance</u>	<u>Probability</u>	<u>Support</u>
8	9	Ø	No	p = .2223	No
9	20	+	Yes	p = .0145	Yes
9a	36	+	Yes	p = .0415	Yes
9b	37	+	Yes	p = .0107	Yes
10	27	+	No	p = .4558	No

¹ + means movement is in the predicted direction, Ø means direction of movement cannot be determined, and - means movement is not in the predicted direction.

H_{10} was not found to be statistically significant, although movement was generally in the predicted direction, except for pay grades E6 to E8. As stated earlier, question 27, upon which H_{10} was based, could be measuring something other than acceptance of JGMs. This may help explain why no statistical significance was found for this hypothesis. However, this explanation is purely conjectural.

H_{9a} and H_{9b} were established to help explain any significant findings to H_9 . Both H_{9a} and H_{9b} show an increasing preference for traditional TOs as pay grade is increased. However, for routine jobs, H_{9a} checklists were most preferred and JGMs were the second most preferred by all pay grades. For non-routine jobs, H_{9b} traditional TOs and JGMs were the most preferred.

Research Hypothesis 4 (H_{10} through H_{14})

Lower grade technicians perceive the job guides to be more usable than do higher grade technicians.

Statistical Hypothesis 10

This hypothesis is the same as H_{10} under Research Hypothesis 3. The same findings and comments made beginning on page 134 apply.

Statistical Hypothesis 11

A greater proportion of lower grade technicians feel that JGMs are a better source of information for their jobs than the old TOs than does the proportion of higher grade technicians.

1. Survey Question 26. As a source of information for your job, the new job guide manuals are:

- a. Much better than the old TOs
- b. Better than the old TOs, but can be improved. Require refinement.
- c. No better than the old TOs
- d. Worse than the old TOs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 18

Responses to Question 26 By Grade
(Kruskal-Wallis One-Way ANOVA)

Pay Grade	Response			
	a	b	c	d
E2 and E3 (N = 27)	3	18	3	3
E4 (N = 63)	14	26	15	8
E5 (N = 39)	6	19	5	9
E6 (N = 16)	1	8	2	5
E7 and E8 (N = 13)	6	3	2	2
WG 10 (N = 25)	1	16	6	2
WG 11 (N = 27)	4	12	6	5
Total (N = 210)	35	102	39	34

Computed $\chi^2 = 5.3383$; d.f. = 6; p = .5012.

3. Comments

No statistical significance was found between the responses to this question when they were compared by pay grade of the respondents. The proportion of respondents for each pay grade who felt that JGMs were "better" or "much better" than the old C-141A TOs generally decreased as pay grade increased. However, E7s, E8s, and WG 10s were an exception to this trend (see Figure 7).

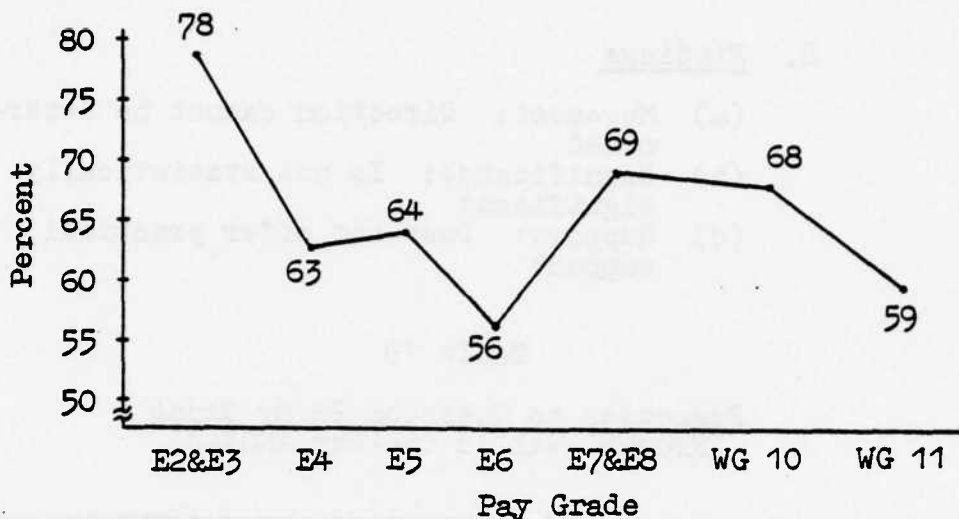


Figure 7

Percent of Respondents by Grade Who Felt That
JGMs Were Better Than the Old TOs

Statistical Hypothesis 12

A greater proportion of lower grade technicians feel that job guides are more valuable for OJT than the old TOs than does the proportion of higher grade technicians.

1. Survey Question 28. How valuable do you think the job guides are to OJT?

- a. Valuable--much better than the old TOs
- b. Valuable--about the same as the old TOs
- c. Of little value--about the same as the old TOs
- d. Of no value--much worse than the old TOs

2. Findings

- (a) Movement: Direction cannot be determined
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 19

Responses to Question 28 By Grade
(Kruskal-Wallis One-Way ANOVA)

Pay Grade	Response			
	a	b	c	d
E2 and E3 (N = 27)	13	10	4	0
E4 (N = 64)	27	22	8	7
E5 (N = 38)	19	11	5	3
E6 (N = 15)	6	6	2	1
E7 and E8 (N = 13)	4	6	2	1
WG 10 (N = 25)	9	12	3	1
WG 11 (N = 27)	14	5	6	2
Total (N = 209)	92	72	30	15

Computed $\chi^2 = 1.8283$; d.f. = 6; p = .9348.

3. Comments

No statistical significance was found between the responses to this question when they were compared by the pay grade of the respondents. There was no discernable trend evident among the proportion of respondents

for each pay grade who felt that job guides were valuable for OJT. A large proportion of the respondents for each pay grade felt that job guides were valuable for OJT (see Figure 8).

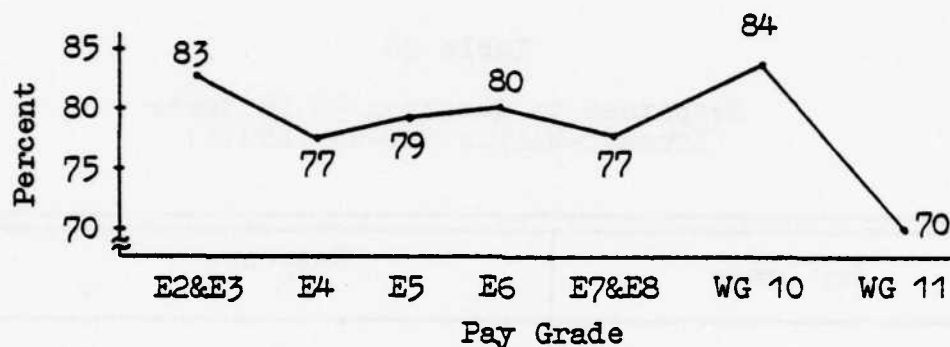


Figure 8

Percent of Respondents by Grade Who Felt That
Job Guides Are Valuable for OJT

Statistical Hypothesis 13

A greater proportion of lower grade technicians feel that JGMs and LTTAs will help them do their job better than does the proportion of the higher grade technicians.

1. Survey Question 33. Do you think that the new job guide manuals and troubleshooting aids have helped (or will help) you do your job?

- a. Better
- b. About the same
- c. Not as well

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is statistically significant
- (c) Support: Does offer practical support

Table 20

Responses to Question 33 By Grade
(Kruskal-Wallis One-Way ANOVA)

Pay Grade	Response		
	a	b	c
E2 and E3 (N = 60)	44	15	1
E4 (N = 70)	23	38	9
E5 (N = 48)	20	19	9
E6 (N = 18)	7	9	2
E7 and E8 (N = 14)	6	5	3
WG 10 (N = 24)	4	17	3
WG 11 (N = 29)	7	17	5
Total (N = 263)	111	120	32

Computed $\chi^2 = 34.6451$; d.f. = 6; p = .0000.

3. Comments

A statistical significance was found between the responses to question 33 when they were compared to the pay grade of the respondents. The proportion of the respondents for each pay grade who felt that job guides

have helped them do their job better generally decreased as pay grade increased. However, E4s and WG 10s showed a more negative attitude than the general overall trend of the sample population (see Figure 9).

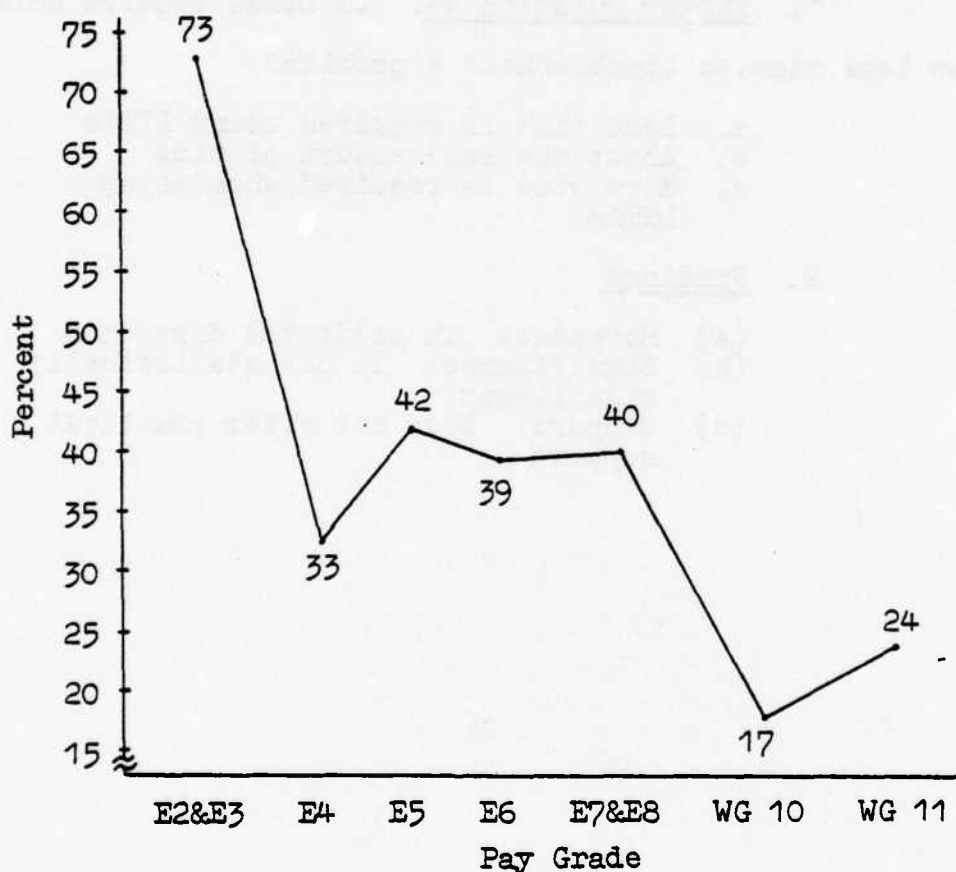


Figure 9

Percent of Respondents by Grade Who Felt That Job Guides Have Helped Them Do Their Job Better

Statistical Hypothesis 14

A greater proportion of lower grade technicians feel that LTTAs require less time to troubleshoot than does the proportion of higher grade technicians.

1. Survey Question 44. Do LTTAs require more or less time to troubleshoot a problem?

- a. Less time is required using LTTAs
- b. About the same amount of time
- c. More time is required when using LTTAs

2. Findings

- (a) Movement: In predicted direction
- (b) Significance: Is not statistically significant
- (c) Support: Does not offer practical support

Table 21

Responses to Question 44 By Grade
(Kruskal-Wallis One-Way ANOVA)

Pay Grade	Response		
	a	b	c
E3 (N = 19)	5	11	3
E4 (N = 25)	5	13	7
E5 (N = 20)	4	7	7
E6 (N = 5)	1	1	3
E7 and E8 (N = 8)	1	3	4
WG 10 (N = 12)	0	7	5
WG 11 (N = 19)	1	8	10
Total (N = 108)	17	50	41

Computed $\chi^2 = 9.3771$; d.f. = 6; p = .1535.

3. Comments

No statistical significance was found between the responses to this question when they were compared by pay grade of the respondents. The proportions of respondents for each pay grade who felt that less time or about the same time was required to troubleshoot a problem generally decreased as pay grade increased. However, E6s were below this general trend and WG 10s were above it (see Figure 10).

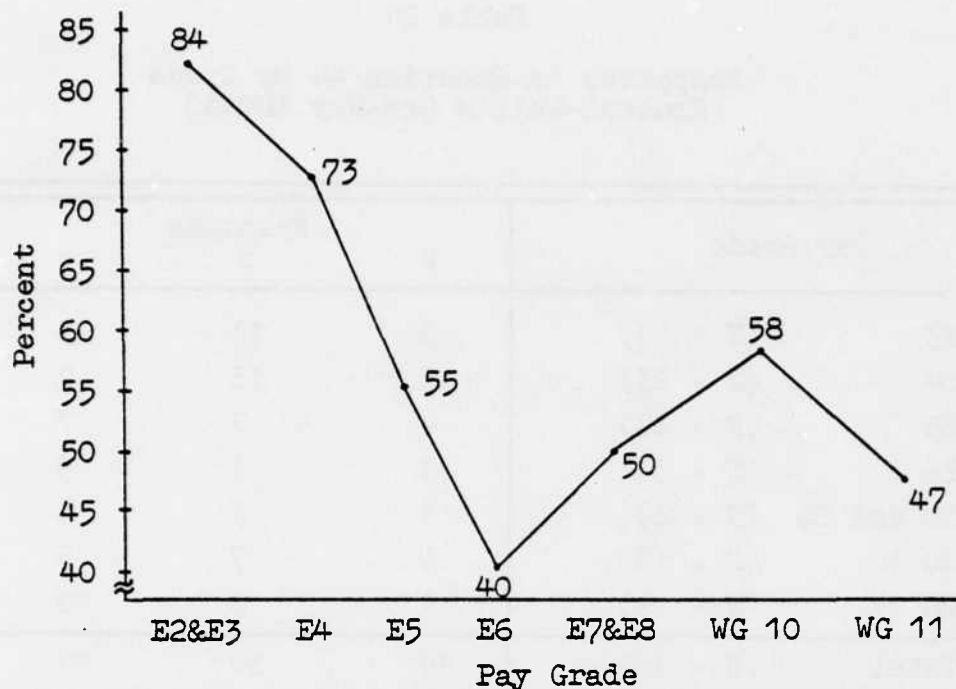


Figure 10

Percent of Respondents by Grade Who Felt That
Less or About the Same Time Was Required
to Troubleshoot a Problem Using LTTAs

Conclusion

The results of testing H_{10} through H_{14} , which are summarized in Table 22, do not provide adequate support to accept Research Hypothesis 4. The criteria tests established in Chapter 3 required that H_{11} plus any two of the other four statistical hypotheses be found statistically significant in the predicted direction.

Table 22

Research Hypothesis 4: Hypothesis Test Results

<u>Hypothesis Number</u>	<u>Question Number</u>	<u>Movement¹</u>	<u>Significance</u>	<u>Probability</u>	<u>Support</u>
10	27	+	No	p = .4558	No
11	26	+	No	p = .5012	No
12	28	Ø	No	p = .9348	No
13	33	+	Yes	p = .0000	Yes
14	44	+	No	p = .1535	No

¹ + means movement is in the predicted direction, Ø means direction of movement cannot be determined, and - means movement is not in the predicted direction.

Only H_{13} was found to be statistically significant. However, four of the five hypotheses were found to have movement in the predicted direction.

Discussion

General findings. Generally, the responses to the current survey were favorable towards the C-141A Job Guides. Seventy-four percent of the respondents indicated that JGMs were "completely satisfactory" or "good, but could be improved." Job guide-style TOs were preferred over all other types of technical data by 45 percent of the respondents. Only 12 percent of the respondents thought that JGMs would not help them do their job "better" or "about the same."

The best liked features of the job guides were their size and step-by-step procedures. Fifty-nine percent of the respondents liked having detailed illustrations keyed to the step-by-step procedures, while only nine percent did not. Forty-one percent of the respondents felt that the job guides contained all of the information necessary for "all" or "most" jobs. On the other hand, 52 percent felt that, although the job guides were useful, some information was missing for some jobs.

Ninety-six percent of the respondents indicated that the procedures were "always" or "mostly" correct. Fifty-three percent of the respondents indicated that they had "a lot" or "some" problems with lost, torn, or dirty pages. Seventy-nine percent of the respondents felt that job guides were valuable to OJT. JGMs were a better source of information for their jobs according to 65 percent of the respondents.

In addition to the objective responses to the questions, many respondents wrote in subjective comments on the questionnaire. These comments were analyzed for both positive and negative factors of the job guide series of technical data for the C-141A. The following factors were found to be those most commonly identified by users as positive factors:

1. The compact size of the JGMs was the most frequently cited positive factor among all skill levels and AFSCs surveyed. Respondents stated that the small size permitted the JGMs to be carried easily to and from the flight line work areas and handled more easily than TOs while performing the actual work. This commonly cited positive factor complements the findings in the AFHRL survey.

2. The value of job guides in on-the-job training was identified due to simplicity, basic readability, step-by-step procedures, and illustrations. This factor was predominately cited by E7 through E9 personnel. The use of job guides in conjunction with Air Training Command Field Training Detachment instruction was viewed as being very beneficial in the OJT area.

3. As was indicated by the AFHRL survey respondents, the current survey respondents stated that the job guide format makes them easy to read, understand, and use. The uncomplicated format makes job guides convenient for quick reference and comparable to checklists in some respects.

On the other hand, the following factors constituted the most frequently cited negative factors impacting usability and acceptance of the C-141A Job Guides:

1. As was found in the AFHRL survey, many respondents in the current survey were simply still not aware of, or familiar with the GAM, the MSIM, or the LTTAs. Consequently, numerous complaints were recorded concerning lack of detail and specific information for certain jobs, when in all probability the required information may have been contained in these manuals.

Nevertheless, respondents who indicated a need for more detail tended to prefer the traditional TOs over job guides in this area.

2. Numerous complaints were registered regarding the illustrations in the job guides. A strong cross section of all AFSCs and skill levels indicated a problem with the illustrations wearing and tearing out after continuous use. Also, difficulty in properly folding the illustrations back into place was mentioned by several respondents. These problems apparently were more noticeable after job guide use during inclement weather. Also, a need for more detail and clarity in the illustrations for some of the smaller jobs was cited.

3. The pages of the JGMs were commented on as simply tearing out too easily. This was one of the first complaints made by users during the AFHRL test phase, and the problem does not appear to have improved to date.

4. The requirement to have three or more specific job guides at hand in order to perform three or more different jobs on an aircraft was an irritant to many maintenance personnel. As an example, one respondent in the current survey stated that to do his job he needed ten job guide books, two manuals, two GAMS, two

MS Manuals, and two WD Manuals for a total of 18 books. Whereas, on the other hand, under the old system (TO) he needed only five books (the 2-2, 2-4, 2-6, 2-8, and 2-11 series TOs).

Research Hypotheses

All four research hypotheses were based on the theory of resistance to change as discussed in Chapter 2. According to this theory, participation in a planned change, by the workers affected, frequently reduces the workers' resistance to that change. Also, younger individuals tend to resist change less than do older individuals.

The findings of this study suggest that participation in a planned change may reduce workers' resistance to change. Research Hypothesis 1 dealt with the degree of user acceptance at bases which participated in the development and pre-implementation testing of C-141A Job Guides and at bases which did not participate at all. This research hypothesis was accepted. However, the degree of user acceptance found at the bases which did not participate in the development and testing of the C-141A Job Guide was almost as favorable as those that did participate. There was little practical

difference found between the two surveys. The user acceptance of C-141A Job Guides measured by both the AFHRL survey and the current survey were generally very favorable. This finding suggests that while participation may have some effect on reducing resistance to change, the most important factor in reducing resistance to change may be the quality of the change itself. A change which proved to be of some benefit to those involved in it should go a lot further towards reducing resistance to change than worker participation in a change which provided little or no benefits.

Research Hypothesis 2 dealt with the degree of perceived usability of C-141A Job Guides at bases which participated in the development and pre-implementation testing of the job guides and at bases which did not participate at all. Again, this hypothesis was based on the theory that participation can reduce resistance to change. This hypothesis was not accepted. Movement in the predicted direction in the majority of questions dealing with perceived usability suggests that the theory behind this hypothesis may be correct. However, the movement was too slight to provide any support to this theory. Again, the responses to the current survey

showed little, if any, practical difference from the responses obtained by the AFHRL survey.

Research Hypotheses 3 and 4 were based on the theory that younger individuals tend to resist change less than do older individuals. Pay grade was used as the variable by which the questionnaire responses were compared. It was felt that pay grade had some relation to the amount of time that individual C-141A maintenance technicians had invested in learning to use the old C-141A TOs. However, it was realized that pay grade was not completely satisfactory for this purpose. An attempt was also made to determine if any other variable, generally related to the amount of time a technician had invested in learning to use the old C-141A TOs, showed more significant differences between the responses. The responses to all questions in the current survey were compared by pay grade, time spent in aircraft maintenance, and time spent in C-141A maintenance. The results of this comparison by individual question are contained in Appendix J and a summary of the results is shown in Table 23. As might be expected, time spent in aircraft maintenance provides more significant differences than pay grade, which was the variable used in

Table 23
Summary of Comparisons of Questions
by Time Related Variables

<u>Variable</u>	<u>Number of Questions Significant</u>	<u>Number of Questions Not Significant</u>
<u>Acceptance</u>		
Pay Grade	6	11
Time in Aircraft Maintenance	7	10
Time in C-141A Maintenance	6	11
<u>Usability</u>		
Pay Grade	3	19
Time in Aircraft Maintenance	6 ¹	16
Time in C-141A Maintenance	4 ¹	18

¹Question 25 was significant in the opposite direction from that predicted.

Research Hypotheses 3 and 4. Surprisingly time spent in aircraft maintenance also provides more significant differences than time spent in C-141A maintenance. However, had time spent in aircraft maintenance, instead of pay grade, been used as the variable in Research Hypotheses 3 and 4, there still would have been insufficient support for accepting either research hypothesis. Also, regardless of the time variable selected, more significant differences were found on questions measuring acceptance than on questions measuring perceived usability. This finding, together with the findings in Research Hypotheses 1 and 2, suggest that user acceptance is more subject to resistance to change than perceived usability.

Questions 47 and 48

Questions 47 and 48 were added to the current survey in an attempt to relate responses to the theory of attitude formation. According to theory, peer groups play a large part in the formation of individual attitudes. However, these questions provided no insight into how individual respondents' attitudes toward C-141A Job Guides were formed. Respondents were asked what most influenced

their preference for job guides or the old C-141A TOs. Respondents were instructed to answer either question 47 or 48, but not both. Additionally, respondents who had no preference, or had not used the old C-141A TOs, were instructed to skip both questions. However, about 11 percent of the respondents still answered both questions. Thus, it was not clear if they preferred job guides or the old C-141A TOs. Of those respondents who answered only question 47 or 48, the vast majority indicated that their own experience with using job guides most influenced their preference. Twenty-eight respondents selected response d to either question 47 or 48 and wrote in what features they liked best or least about job guides. Only nine respondents indicated that their preference was most influenced by other people in their shop, and only one indicated that his preference was most influenced by his supervisor. In view of the responses received to question 47 and 48, no attempt was made to analyze the responses to these questions.

Usage

One of the most significant findings of the current survey was the low utilization of job guides

by C-141A maintenance technicians. Question 46 asked respondents how often they follow the step-by-step procedures (or bold face headings) when performing routine maintenance. Over 56 percent of the respondents indicated that they hardly ever used JGMs or that they only used the step-by-step procedures when they ran into problems or forgot the procedures. Only 19.1 percent of the respondents indicated that they followed the procedures for all jobs. Even more surprisingly is the fact that the above percentages were generally consistent across all pay grades. It appears that younger technicians follow the step-by-step procedures as little as the older technicians. Similar findings were obtained with regards to the use of LTTAs for troubleshooting aids.

Question 41 asked respondents what they preferred to use on troubleshooting jobs. Over 56 percent of the respondents preferred not to use LTTAs at all or only for the most difficult troubleshooting tasks. Only 13.4 percent of the respondents preferred to use LTTAs for all troubleshooting tasks. Again, there were no significant differences found when the responses to this question were compared by pay grade.

As discussed in Chapter 1, evidence from experiments and field tests using job-guide type technical data suggest that significant cost savings could result from the use of job guides. However, these cost savings will only materialize if job guides are used by the majority of technicians.

To see if there was any relationship between how frequently an individual uses JGMs and his attitude towards C-141A Job Guides, questions 9 to 45 were compared by the individual's response to question 46. Of the 36 comparisons made, 17 were found to be statistically significant at the .05 level. The χ^2 test was used for these comparisons since there was insufficient time to use the Kruskal-Wallis test on ordinal level questions. A check was also made to see if there was any relationship between how frequently an individual preferred to use LTTAs and his attitude towards C-141A Job Guides. Question 9 to 40 and 42 to 46 were compared by the individual's response to question 41. Of the 36 comparisons made, 18 were found to be statistically significant at the .05 level using the χ^2 test. These findings suggest that there may be a relationship between an individual's attitude toward C-141A Job Guides

and how frequently he uses JGMs and LTTAs. However, any further examination of this potential relationship is beyond the scope of this thesis and is left for a follow-on research effort.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presents the conclusions and recommendations of this research effort. First, a summary of significant findings will be related to the five objectives and relevant conclusions drawn. Second, some general recommendations for further research concerning user acceptance and perceived usability of C-141A Job Guides will be offered.

Objectives and Findings

Objective 1. Objective 1 was to measure current attitudes of C-141A maintenance technicians toward C-141A Job Guides at two bases which did not participate in the development and pre-implementation testing of the C-141A Job Guides.

This objective was satisfied by administering a survey questionnaire to 273 C-141A maintenance technicians at McChord and McGuire AFBs. In general it was found that the survey respondents had a favorable attitude toward C-141A Job Guides; job guides were generally preferred by the respondents over all other

forms of technical data. Most of the new features of the job guides, such as size and step-by-step procedures, were well liked by a large majority of the respondents. Most of the respondents found the job guides to be very usable, particularly for OJT. However, the responses indicated that there are still some technical problems, such as trouble with lost pages and some missing information, with the C-141A Job Guides.

One significant finding was that despite the fact that the C-141A Job Guides have been generally well accepted, only a small minority of the technicians appear to be using them consistently. This pattern could reduce, or eliminate, the significant cost savings suggested by previous experiments with job guide type technical data.

Based on these overall findings, it is concluded that user attitudes about C-141A Job Guides are generally favorable, although there are some technical problems which remain to be resolved.

Objective 2. Objective 2 was to compare user acceptance of C-141A Job Guides as measured by this survey with user acceptance as measured by the AFHRL Phase III survey questionnaire.

This objective was satisfied by conducting a test of significance on each of the five statistical hypotheses which comprised Research Hypothesis 1. It was found that the user acceptance of C-141A Job Guides as measured by this survey was lower than that measured by the AFHRL survey. User acceptance, however, was found to be basically high and generally only a few percentage points less favorable than the degree of acceptance found by AFHRL. Thus, findings of this survey basically support the favorable user acceptance of C-141A Job Guides as measured by the AFHRL survey.

Some resistance to change was evident in both this survey and the AFHRL survey. It appears that participation by workers in a planned change which affects them, as suggested by behavioral theorists, may have some effect on reducing workers' resistance to change.

Based on these findings, it is concluded that technicians at bases which participated in the development and pre-implementation testing of C-141A Job Guides do have a slightly higher degree of acceptance of the job guides than do technicians at bases which did not participate in the development and pre-implementation testing.

Objective 3. Objective 3 was to compare perceived usability of C-141A Job Guides as measured by this survey with perceived usability as measured by the AFHRL Phase III survey questionnaire.

This objective was satisfied by conducting a test of significance on each of the five statistical hypotheses which comprised Research Hypothesis 2. It was found that perceived usability of C-141A Job Guides, as measured by this survey, was not significantly different from that measured by the AFHRL survey. In both surveys, the perceived usability of C-141A Job Guides was found to be generally very favorable.

It is, therefore, concluded that technicians at bases which participated in the development and pre-implementation testing of the C-141A Job Guides do not perceive the job guides to be significantly more usable than do technicians at bases which did not participate in the development and pre-implementation testing.

Objective 4. Objective 4 was to compare user acceptance of C-141A Job Guides by the grade of the respondents.

This objective was satisfied by conducting a test of significance on each of the five statistical hypotheses which comprised Research Hypothesis 3. No

significant difference was found between pay grades with regards to user acceptance of C-141A Job Guides as measured by this survey. This finding provides no support for the theory that younger individuals tend to resist change less than older individuals. If a significant difference had been found between pay grades, it might have been suggested that even though user acceptance of the C-141A Job Guides is high, acceptance should increase even more as older airmen leave the service and are replaced by new entries to the career field. However, since no significant difference was found, no support can be offered for this proposition.

Based on these findings it is concluded that lower grade technicians do not have a significantly higher degree of acceptance of the job guides than do higher grade technicians.

Objective 5. Objective 5 was to compare perceived usability of C-141A Job Guides by the grade of the respondents.

This objective was satisfied by conducting a test of significance on each of the five statistical hypotheses which comprised Research Hypothesis 4. No significant difference was found between pay grades

with regards to perceived usability of C-141A Job Guides as measured by this survey. This finding also provides no support for the theory that younger individuals tend to resist change less than older individuals.

Therefore, it is concluded that lower grade technicians do not perceive the job guides to be more usable than do higher grade technicians.

Recommendations for Future Research

One major area of interest which is recommended for future research is an additional survey of user acceptance and perceived usability of job guides for an aircraft system that is new to the Air Force inventory. As stated in this thesis, some evidence of resistance to change was found in both this survey and the AFHRL survey. This resistance may have been due in part to the amount of time technicians had invested in learning to use the old C-141A TOs. Further, attitudes towards job guides may be even more favorable when maintenance technicians are exposed to job guides from the inception of a new weapon system and are not involved with the use of more traditional style TOs for that same weapon system. The scope of such a research effort should also include an attempt to determine if usage of job guides

for maintenance tasks is higher than was found by this survey.

Second, a survey of technicians at an overseas consolidated aircraft maintenance organization who currently use both the old traditional style TOs and the new C-141A Job Guides in the daily performance of their duties is recommended. This approach would allow survey respondents to make a more objective comparison between traditional TOs and job guides, instead of relying on their past knowledge of the traditional TOs.

Third, an area of interest which is recommended for future research is an attempt to determine why usage of C-141A Job Guides is so low. This effort should also attempt to determine the extent of any relationship between user attitudes towards C-141A Job Guides and the frequency with which they are used. In anticipation of future research in this area, the data base which was created from the current survey questionnaire responses has been permanently saved on a computer card file. Individuals interested in the data file, as well as future research in the job guide area, should contact Mr. Robert C. Johnson, AFHRL/ASR, Wright-Patterson AFB, Ohio.

APPENDIX A
DESCRIPTION OF THE FIVE TYPES
OF JOB GUIDE MANUALS

DESCRIPTION OF THE FIVE TYPES OF JOB GUIDE MANUALS

Job guide manual (JGM). JGMs provide proceduralized step-by-step instructions for all commonly performed tasks, with the exception of troubleshooting. There are 63 JGMs, broken down by tasks, for the C-141A. A JGM consists of a preliminary information page, one or more pages of proceduralized step-by-step instructions, and a fold-out page of illustrations of each of the components referenced in the instructions. The preliminary information page, called input conditions, provides all the information which is needed to begin a job, including parts and supplies, tools, test equipment, personnel, and safety information. The step-by-step instructions tell exactly how the job is to be done and are written in two levels of detail. First, the general instruction is given in bold-face print. This is followed by detailed instructions for accomplishing the sub-tasks. Fully qualified technicians are only required to follow the bold-face instructions. Less experienced technicians are required to follow the detailed step-by-step instructions. All components referred to in the instructions and their location in

the aircraft are illustrated on the fold-out illustrations page. Numbered arrows are used to relate the illustration to the specific instruction which deals with it. The job guides are printed on 4 by 8 inch paper and placed in small loose-leaf binders for convenience (22:4-5). Figure 11 is an example of the type of instructions contained in a JGM, and Figure 12 shows the illustration which is keyed to this instruction.

Maintenance support information manual (MSIM). A MSIM presents information which is infrequently used or is not appropriate for presentation in the JGMs or troubleshooting manuals. It includes a list of special tools and test equipment, required charts, graphs, tables, and statistical data. When the MSIM is required for a job, it is usually listed on the input conditions page of the JGM. The MSIM contains a table of contents which is similar to those in conventional TOs (22:5).

General aircraft manual (GAM). General information about the aircraft is contained in the GAM. It includes system functional descriptions as well as a description of the C-141A general arrangements, dimensions, station diagrams, walkways, etc. Information in the GAM is also located by using a table of contents (22:5).

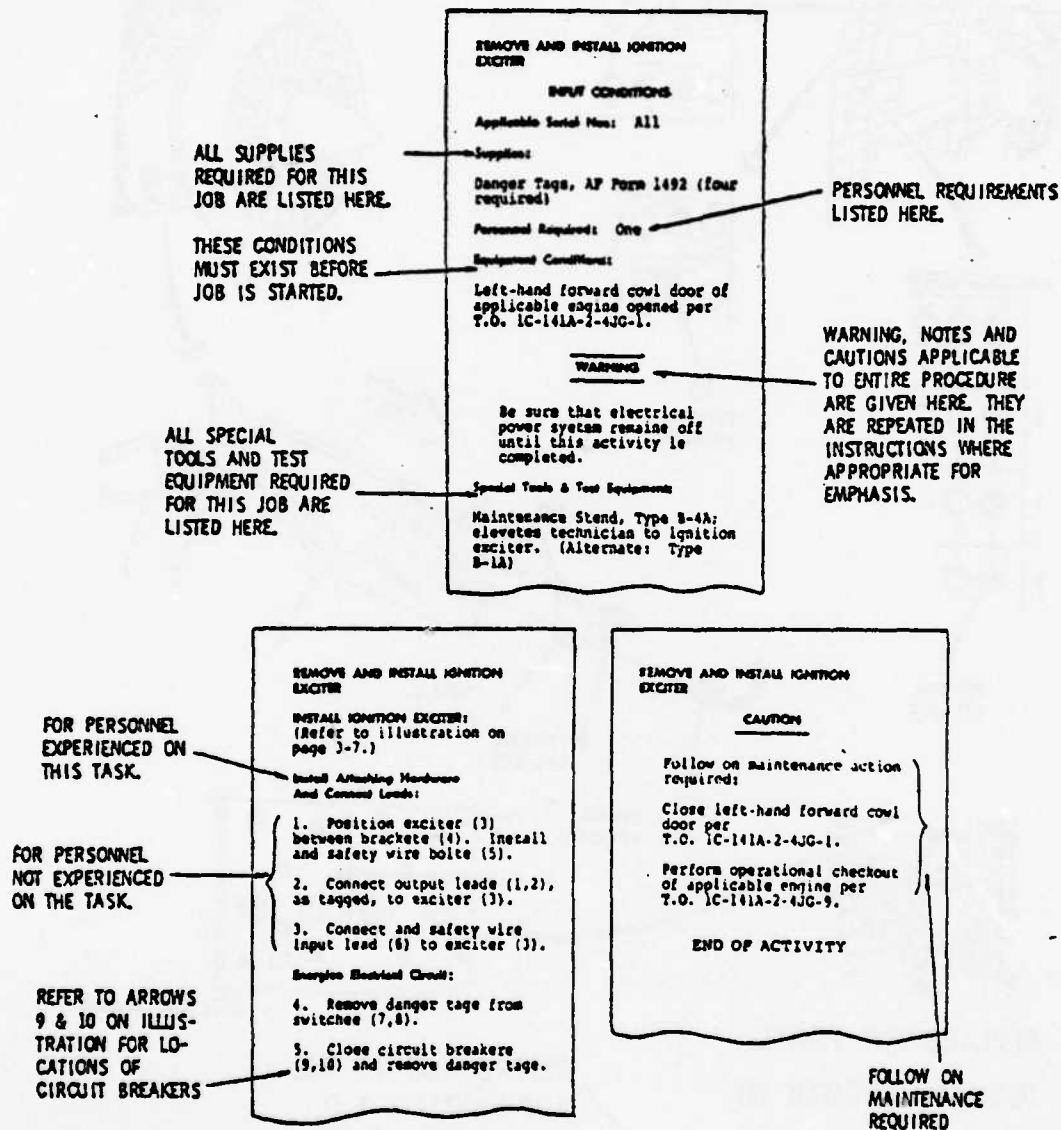
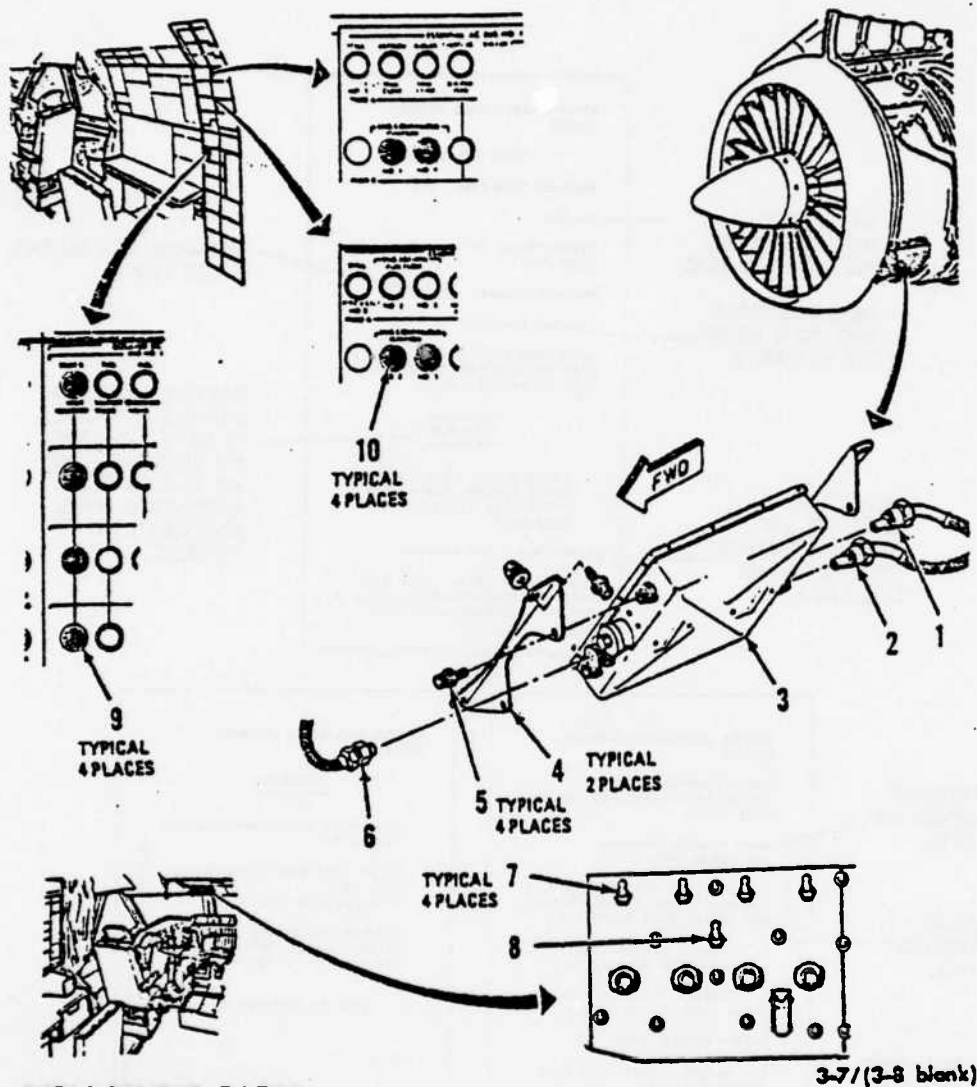


Figure 11
Example of JGM Instructions



REPLACEMENT PARTS:

IGNITION EXCITER (3)

REFER TO ILLUSTRATED
PARTS BREAKDOWN,
T.O. 2J-TF33-14, FIGURE 60.

REFERS YOU TO THE
APPROPRIATE T.O.
AND FIGURE FOR
INFORMATION ON
REPLACEMENT PARTS.

Figure 12

Illustration Keyed To Instruction
Shown in Figure 11

AD-A047 141

AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO SCH0--ETC F/G 5/9
AN ANALYSIS OF USER ACCEPTANCE AND PERCEIVED USABILITY OF C-141--ETC(U)
SEP 77 S A RICHARDSON, T E SYSTER
AFIT-LSSR-36-77B

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3 of 3

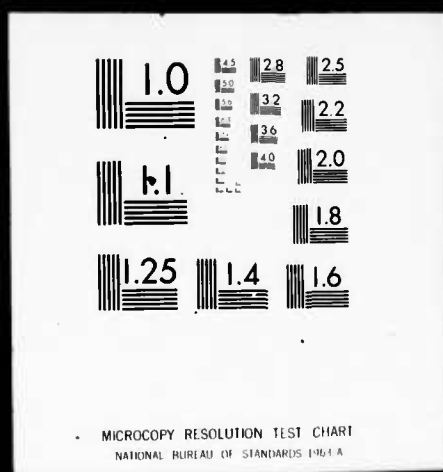
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Wiring diagrams manual (WDM). The WDM contains diagrams of all C-141A wiring and drawings showing the location of connectors, ground points, terminal boards, and splice areas. A coordinate system is used with the WDM to facilitate location of specified wiring. Instructions for using the WDM are contained in Section II of TO 1C-141A-2-11WD-1 (22:6).

Logic tree troubleshooting aids (LTTA). Troubleshooting is performed by first identifying the malfunction symptoms while performing a system checkout using the checkout procedure in the JGM. Next, the technician locates the symptoms in either the troubleshooting index volume (TO 1C-141A-2-1TS-1) or at the front of the troubleshooting procedures for each symptom. The listing of symptoms either specifies the corrective action or refers the technician to a troubleshooting procedure called an "action tree." The action tree is followed until the cause of the malfunction is isolated. An example of the listing of malfunction symptoms and a typical action tree is shown in Figure 13. The LTTAs are supported by illustrations similar to those provided with JGMs. As in the JGMs, numbered arrows key the illustrations to

SECTION V
HYDRAULIC SYSTEM NO. 3

S-1. This section contains troubleshooting information for the No. 3 Hydraulic System. Malfunction symptoms that may be observed during operational checkout of the system are listed in table S-1, together with a reference to the appropriate troubleshooting action tree or directly replaceable component as applicable. Refer to figure S-1 for location of system components and troubleshooting test points. Refer to T.O. 1C-141A-2-1GA-2 for No. 3 Hydraulic System Fluid Flow Schematic.

NOTE

Lighted panel indicators have two bulbs. If any indicator is half lit prior to start of troubleshooting, replace defective bulb.

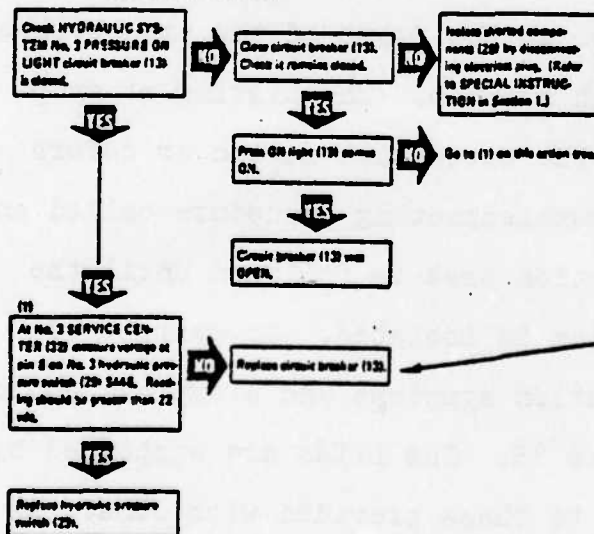
Table S-1. No. 3 Hydraulic System Index of Malfunction Symptoms

MALFUNCTION SYMPTOM	ACTION TREE NO. OR FAULTY COMPONENT
No. 1 Pump Does Not Run With Switch At Flight Station	AT S-1
Emergency Brake Pressure Reads More Than 1500 PSI But Pressure On Light Is Not On	AT S-2
Press On Light Is On But Emergency Brake Pressure Reads Less Than 1500 PSI	AT S-3
No. 3 Hydraulic System Pressure Gauge Does Not Indicate Pressure	AT S-4
Emergency Brake Pressure Reads Less Than 2850 PSIG Or More Than 3150 PSIG	AT S-5
Emergency Brake Pressure Gauge Fluctuates More Than 75 PSI When Tapped	Gage (17)
No. 3 Hydraulic System Pressure Gauge Fluctuates More Than 75 PSI When Tapped	Gage (22)
Emergency Brake Pressure Drops Off Rapidly When Brakes Are Actuated With No. 1 Pump Off	AT S-6

GO TO ACTION TREE 52.

REPLACE GAUGE (IDENTIFIED BY ARROW 17 ON ILLUSTRATION FOLDOUT)

AT S-2. HYDRAULIC SYSTEM NO. 3 EMERGENCY BRAKE PRESSURE READS MORE THAN 1500 PSIG BUT PRESS ON LIGHT IS NOT ON



IDENTIFIED BY ARROW 13 ON ILLUSTRATION FOLDOUT.

Figure 13

Example of a Listing of Malfunction Symptoms and an Action Tree

the instructions. Some of the more complex systems also contain functional wiring diagrams as part of the troubleshooting procedures (22:6).

APPENDIX B
AFHRL PHASE III FINDINGS

AFHRL PHASE III FINDINGS

The following factors were found to be those most commonly identified by users as positive factors of the job guide series of technical data for the C-141A (22:38-39):

1. The small 4 by 8 inch size of the JGMs allow them to be carried in tool bags and taken into small tight working areas. In addition, they will lie flat and open for use.

2. Unlike the old TOs, job guides provide illustrations of all components referenced in the procedures.

3. The format of the job guides make them easier to read, understand, and use than the old TOs.

4. The input conditions page of the JGMs simplifies the preparation for the job by specifying all requirements to start the task.

5. The dual level feature of the JGMs allows experienced technicians to review only bold-face headings prior to each job rather than being required to follow each step in sequence.

The following factors were found to be those most commonly identified by users as negative factors

affecting usability and user acceptance of the job guide series of technical data for the C-141A (22:39-43).

1. Many of the users were not aware of, or familiar with, the GAM, the MSIM, or the LTTAs. This caused many users to complain about the lack of information, when the information was frequently contained in these manuals.

2. There was some confusion over how technicians were expected to use the JGMs. Did they have to follow every step or were they only required to have the JGM in the immediate area?

3. Because there was inadequate storage space for the job guides on the aircraft, they were placed in the aircraft in large cardboard boxes. The manuals soon became jumbled and created a very time consuming task to find a specific manual.

4. Sometimes manuals could not be located. They were later found in such places as tool boxes and inaccessible areas of the aircraft. Thus, the convenient size of the JGMs did have some negative features.

5. Most users felt that more danger tags are required than are really necessary. This proved to be

an irritation because danger tags are controlled items which must be obtained and filled out.

6. Technicians complained that the long check-out procedures are too time consuming to use in a time-critical situation.

7. Many technicians felt that the troubleshooting data were incomplete and do not contain all the possible malfunctions.

8. The index volume only covers the JGMs. Because of this feature, users report difficulty in locating specific information or task data.

9. Up to three manuals are required for troubleshooting, repair, and checkout of some systems. This irritated some users.

10. Many complaints were received about errors in the manuals. All errors identified have been turned in for correction.

11. Resistance to change was evident, particularly among the experienced technicians, and especially the civilians. These personnel were thoroughly familiar with the old TOs and resented having to become familiar with the new technical data. However, there was a noticeable improvement since Phase II among all personnel in the general acceptance of the job guides.

12. Because of the low quality paper used and holes punched close to the edge of the paper, the pages of the JGMs tear out easily. This problem will increase with time and could lead to maintenance being performed without the use of technical data.

APPENDIX C

SURVEY QUESTIONNAIRE

APPENDIX C

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY (AU)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433




REPLY TO: LSGR (LSSR 36-77B/Major Richardson/Captain Syster/
ATTN OF: AUTOVON 787-7769)

SUBJECT: C-141A Job Guide User Attitudes Survey

6 May 1977

TQ:

1. The attached questionnaire was prepared by a research team at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio. The purpose of the questionnaire is to determine how the maintenance technician feels about C-141A Job Guides.
2. You are requested to provide an answer or comment for each question. Headquarters USAF Survey Control Number 77-97 has been assigned to this questionnaire. Your participation in this research is voluntary.
3. Your response to the questions will be held confidential. Please remove this cover sheet before returning the completed questionnaire. Your cooperation in providing this data will be appreciated and will be very beneficial in making improvements and changes to job guides planned for other aircraft systems. Please return the completed questionnaire to the unit project officer.


HENRY W. PARLETT, Colonel, USAF
Associate Dean for Graduate
Education
School of Systems and Logistics

1 Atch
Questionnaire

PURPOSE OF THIS STUDY

This questionnaire is part of a research study of user acceptance and perceived usability of C-141A Job Guides. The research is being conducted by Major S. A. Richardson and Captain T. E. Syster of the Air Force Institute of Technology's Graduate School of Systems and Logistics. The purpose of the research is to find out how you as the user feel about C-141A Job Guides. The results of this study will be used by the Air Force to make improvements and changes to Job Guides planned for other aircraft systems.

INSTRUCTIONS

Please answer the questions on the following pages as honestly and candidly as possible. Indicate how you really feel about the subject. In no way will your responses be traceable to you as an individual nor will any attempt be made to do so. There are no "trick" questions.

Not only will this survey permit you to seriously consider Job Guides and your feelings about them, but it will also give you a means of expressing your opinions without fear of reprisal. Information gathered in this survey may ultimately prove useful in improving conditions in your job.

Keep in mind that this is not a test and there are no "correct" or "incorrect" answers. We want your honest opinion.

There are a total of 48 items on this survey questionnaire. Please select only one answer for each question. If none of the responses to a particular question come close to your feelings about Job Guides, or if the question is unclear, feel free to write any comments on the questionnaire.

In advance, "thank you" for your participation in this study.

USAF SCN 77-97 (Expires 30 September 1977)

PRIVACY STATEMENT

In accordance with paragraph 30, AFR 12-35, the following information is provided as required by the Privacy Act of 1974:

a. Authority

- (1) 5 U.S.C. 301, Departmental Regulations, and/or
- (2) 10 U.S.C. 8012, Secretary of the Air Force, Powers, Duties, Delegation by Compensation; and/or
- (3) DOD Instruction 1100.13, 17 Apr 68, Surveys of Department of Defense Personnel; and/or
- (4) AFR 30-23, 22 Sep 76, Air Force Personnel Survey Program.

b. Principal purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research, based on the data provided, will be included in written master's theses and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or presented orally, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

1. What is your current grade?

<input type="checkbox"/>	a. E1	(0)
<input type="checkbox"/>	b. E2	(9)
<input type="checkbox"/>	c. E3	(52)
<input type="checkbox"/>	d. E4	(71)
<input type="checkbox"/>	e. E5	(49)
<input type="checkbox"/>	f. E6	(19)
<input type="checkbox"/>	g. E7	(10)
<input type="checkbox"/>	h. E8	(4)
<input type="checkbox"/>	i. E9	(0)
<input type="checkbox"/>	j. WG 10	(25)
<input type="checkbox"/>	k. WG 11	(29)
<input type="checkbox"/>	z. No response	(1)

2. What is your AFSC? _____

3. What is your skill level?

<input type="checkbox"/>	a. 3 level	(20)
<input type="checkbox"/>	b. 5 level	(162)
<input type="checkbox"/>	c. 7 level	(77)
<input type="checkbox"/>	d. 9 level	(10)

4. What type of Squadron are you assigned to?

<input type="checkbox"/>	a. AMS	(90)
<input type="checkbox"/>	b. FMS	(84)
<input type="checkbox"/>	c. OMS	(94)
<input type="checkbox"/>	z. No response	(1)

5. What Base are you stationed at?

<input type="checkbox"/>	a. McChord AFB	(137)
<input type="checkbox"/>	b. McGuire AFB	(132)

6. Where did you first use C-141 Job Guides?

<input type="checkbox"/>	a. This base	(251)
<input type="checkbox"/>	b. During ATC training	(12)
<input type="checkbox"/>	c. Charleston AFB	(0)
<input type="checkbox"/>	d. Norton AFB	(0)
<input type="checkbox"/>	e. Some other base	(4)
<input type="checkbox"/>	y. Other or multiple response	(2)

7. How long have you been in aircraft maintenance?

- ☐ a. less than 6 months (6)
- ☐ b. 6 months to 2 years (56)
- ☐ c. 2 years to 4 years (59)
- ☐ d. 4 to 8 years (47)
- ☐ e. 8 to 12 years (27)
- ☐ f. over 12 years (72)
- ☐ z. No response (2)

8. How long have you been working on C-141A aircraft?

- ☐ a. less than 6 months (13)
- ☐ b. 6 months to 2 years (81)
- ☐ c. 2 years to 4 years (74)
- ☐ d. 4 to 8 years (52)
- ☐ e. 8 to 12 years (40)
- ☐ f. over 12 years (7)
- ☐ z. No response (2)

9. How do you like the Job Guide Manuals?

- ☐ a. They are completely satisfactory. (24)
- ☐ b. They are good, but could be improved. (169)
- ☐ c. They are satisfactory, but no better than the old TOs. (44)
- ☐ d. They are unsatisfactory. (27)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (7)

10. The size of the Job Guide Manual is

- ☐ a. Too small (15)
- ☐ b. Too big (10)
- ☐ c. Okay (190)
- ☐ d. Just right (50)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (3)

11. The illustrations are

- ☐ a. Excellent (46)
- ☐ b. Poor (38)
- ☐ c. Okay (182)
- ☐ z. No response (3)

12. Do the job guide procedures contain all the information you need to do the job?

- ☐ a. Yes, for all jobs. (25)
- ☐ b. Yes, for most jobs. (98)
- ☐ c. Some information is missing for some job guides but guides are still useful. (138)
- ☐ d. Missing information makes job guides unusable. (17)
- ☐ y. Other or multiple response. (4)
- ☐ z. No response. (2)

13. Are the procedures correct?

- ☐ a. Almost always (71)
- ☐ b. Mostly (186)
- ☐ c. Seldom (9)
- ☐ d. Never (1)
- ☐ y. Other or multiple response (2)

14. Do you have any difficulty in understanding the procedures?

- ☐ a. Always (3)
- ☐ b. Mostly (14)
- ☐ c. Occasionally (195)
- ☐ d. Never (56)
- ☐ y. Other or multiple response (1)

15. Are too many books required to do one job?

- ☐ a. Always (11)
- ☐ b. Mostly (32)
- ☐ c. Occasionally (154)
- ☐ d. Never (71)
- ☐ z. No response (1)

16. Do you find the procedures in the job guides are too detailed?

- ☐ a. Yes, for most jobs. (32)
- ☐ b. Yes, for some jobs. (92)
- ☐ c. No, about right for most jobs. (142)
- ☐ y. Other or multiple response. (3)

17. Do you use the dual-level feature?

- ☐ a. Mostly (18)
- ☐ b. Seldom (49)
- ☐ c. What is the dual-level feature (191)
- ☐ z. No response (11)

18. Have you had any problems with lost, torn, or dirty Job Guide pages?

- ☐ a. Yes, a lot (62)
- ☐ b. Some (78)
- ☐ c. Very little (63)
- ☐ d. No (64)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (1)

19. Do you use the procedure headings as a checklist?

- ☐ a. Frequently (53)
- ☐ b. Sometimes (156)
- ☐ c. Never (50)
- ☐ z. No response (10)

20. Would you prefer to use (choose one answer only)

- ☐ a. Traditional-style TOs (64)
- ☐ b. Job Guide-style TOs (120)
- ☐ c. Checklists (72)
- ☐ d. No TOs (11)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (1)

21. What do you think is the best feature of the Job Guides? (Choose one answer only.)

- ☐ a. Size (112)
- ☐ b. Simplicity (34)
- ☐ c. Step-by-step procedures (81)
- ☐ d. Illustrations (21)
- ☐ e. Dual-level of instructions (3)
- ☐ f. Other (4)
- ☐ y. Other or multiple response (14)

22. Many of the illustrations are printed on fold-out pages. Does this make the illustrations

- ☐ a. Very convenient to use. (59)
- ☐ b. No problem to use. (148)
- ☐ c. Difficult to use. (61)
- ☐ y. Other or multiple response. (1)

23. The illustrations are

- ☐ a. Necessary to complete most jobs. (25)
- ☐ b. Helpful for most jobs. (164)
- ☐ c. Helpful but usually not necessary. (79)
- ☐ d. Not needed for any job. (1)

24. An index is provided to help you locate information in the job guide manual. The index is

- ☐ a. Very helpful. Permits rapid location of all job guide information. (94)
- ☐ b. Usually helpful. Aids in locating most required job guide information. (172)
- ☐ y. Other or multiple response. (2)
- ☐ z. No response. (1)

25. The GAM provides general information on the AC and its systems. How useful is this manual?

- ☐ a. Very useful. Used frequently. (30)
- ☐ b. Somewhat useful. Used occasionally. (98)
- ☐ c. Seldom useful. Rarely used. (42)
- ☐ d. Have never used it. (88)
- ☐ y. Other or multiple response. (2)
- ☐ z. No response. (9)

Questions 26 to 30 ask for comparisons between C-141 Job Guides and the old C-141 TOs. If you have not used the old C-141 TOs skip questions 26-30, and continue with question 31.

26. As a source of information for your job, the new job guide manuals are

- ☐ a. Much better than the old TOs. (35)
- ☐ b. Better than the old TOs, but can be improved. Require refinement. (102)
- ☐ c. No better than the old TOs. (39)
- ☐ d. Worse than the old TOs. (35)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (57)

27. One of the goals of the JG program is to provide better tech data to encourage use on the job. Do you feel that

- ☐ a. You use JGMs more than the TOs. (70)
- ☐ b. About the same as the old TOs. (106)
- ☐ c. Less than the old TOs. (36)
- ☐ z. No response. (57)

28. How valuable do you think the Job Guides are to OJT?

- ☐ a. Valuable - much better than the old TOs. (92)
- ☐ b. Valuable - about the same as the old TOs. (73)
- ☐ c. Of little value - about the same as the old TOs. (30)
- ☐ d. Of no value - much worse than the old TOs. (15)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (58)

29. If you are an OJT trainer, how valuable are the Job Guides in helping someone learn the aircraft?

- ☐ a. Very valuable - much better than the old TOs. (69)
- ☐ b. Valuable - about the same as the old TOs. (56)
- ☐ c. Of little value - about the same as the old TOs. (23)
- ☐ d. Of no value - much worse than the old TOs. (11)
- ☐ e. I am not an OJT trainer. (46)
- ☐ y. Other or multiple response. (2)
- ☐ z. No response. (62)

30. Less experienced technicians are capable of doing more jobs on the aircraft than they could with the old TOs, because of the detailed procedures in Job Guides.

- ☐ a. I strongly agree. (41)
- ☐ b. I somewhat agree. (86)
- ☐ c. I am undecided. (39)
- ☐ d. I somewhat disagree. (31)
- ☐ e. I strongly disagree. (16)
- ☐ z. No response. (56)

31. Would you recommend that job guide manuals be purchased for use in your shop?

- ☐ a. Yes, for all tasks. (69)
- ☐ b. Yes, for some tasks. (152)
- ☐ c. No (44)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (3)

32. Would you recommend that logic tree troubleshooting aids be purchased for use in your shop?

- ☐ a. Yes, for all tasks. (69)
- ☐ b. Yes, for some tasks. (140)
- ☐ c. No (52)
- ☐ y. Other or multiple response. (3)
- ☐ z. No response. (5)

33. Do you think that the new job guide manuals and troubleshooting aids have helped (or will help) you do your job?

- ☐ a. Better (111)
- ☐ b. About the same (121)
- ☐ c. Not as well (32)
- ☐ y. Other or multiple response (3)
- ☐ z. No response (2)

34. Do you like having detailed step-by-step instructions such as those found in the job guide manuals?

- ☐ a. Yes (158)
- ☐ b. Makes no difference (84)
- ☐ c. No (24)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (2)

35. Do you like having detailed illustrations keyed to the step-by-step procedures?

- ☐ a. Yes (176)
- ☐ b. Makes no difference (74)
- ☐ c. No (17)
- ☐ z. No response (2)

36. Which type of technical data would you prefer to use for routine jobs? (Choose one answer only).

- ☐ a. Traditional TO (36)
- ☐ b. Checklist (114)
- ☐ c. Job Guide Manuals (80)
- ☐ d. Very general procedures (36)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (2)

37. Which type of technical data would you prefer to use for non-routine jobs? (Choose one answer only).

- ☐ a. Traditional TO (92)
- ☐ b. Checklist (33)
- ☐ c. Job Guide Manuals (122)
- ☐ d. Very general instructions (20)
- ☐ z. No response (2)

38. How do you feel about being required to use job guide manuals for every job?

- ☐ a. Pleased (18)
- ☐ b. Mostly pleased (96)
- ☐ c. Somewhat irritated (108)
- ☐ d. Irritated (41)
- ☐ y. Other or multiple response (2)
- ☐ z. No response (4)

39. If you were experienced on another aircraft and transferred to work on the C-141, which of the following would be the most helpful to you in becoming qualified on the C-141? (Choose one answer only).

- ☐ a. ATC school (4)
- ☐ b. FTD school (110)
- ☐ c. OJT (107)
- ☐ d. Job Guide Manuals and Logic Tree Troubleshooting Aids (30)
- ☐ e. Conventional TO (8)
- ☐ y. Other or multiple response (6)
- ☐ z. No response (4)

40. Which of the following do you believe would be the most likely to improve the efficiency of maintenance operations? (Choose one answer only).

- ☐ a. More ATC training (16)
- ☐ b. Better ATC training (36)
- ☐ c. Better conventional TOs (10)
- ☐ d. Job Guide Manuals and Logic Tree Troubleshooting Aids (44)
- ☐ e. More qualified personnel (102)
- ☐ f. Better supply support (48)
- ☐ y. Other or multiple response (8)
- ☐ z. No response (5)

41. Logic tree troubleshooting aids (LTTAs) specify the troubleshooting strategy and provide step-by-step instructions for isolating faults. Do you prefer to:

- ☐ a. Use LTTAs for all troubleshooting tasks. (15)
- ☐ b. Use LTTAs for infrequent troubleshooting tasks only. (34)
- ☐ c. Use LTTAs for the most difficult troubleshooting tasks only. (40)
- ☐ d. Develop own troubleshooting strategy and not use LTTAs at all. (23)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (156)

42. How do you feel about being required to use LTTAs for all troubleshooting jobs?

- ☐ a. Pleased (7)
- ☐ b. Mostly pleased (32)
- ☐ c. Somewhat irritated (49)
- ☐ d. Irritated (24)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (156)

43. Do the LTTAs lead to correct isolation of the problem?

- ☐ a. Yes, always (2)
- ☐ b. Usually (48)
- ☐ c. Sometimes (49)
- ☐ d. Seldom (16)
- ☐ z. No response (154)

44. Do LTTAs require more or less time to troubleshoot a problem?

- ☐ a. Less time is required using LTTAs. (17)
- ☐ b. About the same amount of time. (51)
- ☐ c. More time is required when using LTTAs. (41)
- ☐ y. Other or multiple response. (2)
- ☐ z. No response. (158)

45. The JGM index is?

- ☐ a. Very helpful. (59)
- ☐ b. Usually helpful. (97)
- ☐ c. Sometimes helpful. (71)
- ☐ d. Little or no help. (9)
- ☐ y. Other or multiple response. (2)
- ☐ z. No response. (31)

46. When performing routine maintenance do you?

- ☐ a. Follow the step-by-step procedures (or bold face headings) for all jobs. (48)
- ☐ b. Follow the step-by-step procedures (or bold face headings) for only some jobs. (62)
- ☐ c. Only use the step-by-step procedures (or bold face headings) for reference when you run into problems or forget the procedure. (109)
- ☐ d. Hardly ever use JGMs. (33)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (16)

If you prefer job guides to the old C-141 TOs answer only question 47. If you prefer the old C-141 TOs to Job Guides answer only question 48. If you have no preference or have not used the old C-141 TOs you are finished and should not answer any more questions.

47. What most influenced your preference for Job Guides?

- ☐ a. Personal experience with using Job Guides. (62)
- ☐ b. Other people in my shop. (8)
- ☐ c. My supervisor. (1)
- ☐ d. Other _____ . (17)
- ☐ w. Answered both questions 47 and 48. (30)
- ☐ x. Did not answer questions 26 to 30. (5)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (145)

48. What most influenced your preference for the old C-141 TOs?

- ☐ a. Personal experience with using Job Guides. (45)
- ☐ b. Other people in my shop. (1)
- ☐ c. My supervisor. (0)
- ☐ d. Other _____ . (11)
- ☐ w. Answered both questions 47 and 48. (30)
- ☐ x. Did not answer questions 26 to 30. (4)
- ☐ y. Other or multiple response. (4)
- ☐ z. No response. (174)

Again, thank you for your cooperation and participation
in this study.

APPENDIX D

AFHRL QUESTIONNAIRE

APPENDIX D
JOB GUIDE QUESTIONNAIRE

This survey, prepared by the Air Force Human Resources Laboratory, is a part of the Study of User Acceptance and Usability of the C-141 Job Guides. The data will be used to improve future Job Guide Manual purchases for new aircraft.

Please write your rank, AFSC, and Squadron in the spaces provided below. Your name is not required. Answer the questions as honestly as possible. You may write additional comments if you wish to do so. Remember, your opinions will help improve future technical orders.

RANK _____ AFSC _____ SQUADRON _____ AMS _____ FMS _____ OMS

There are no right or wrong answers. Please indicate your most preferred answer (one) by circling or checking the appropriate letter.

*1. How do you like the Job Guide Manuals?

- ☐ a. They are completely satisfactory. (30)¹
- ☐ b. They are good, but could be improved. (217)
- ☐ c. They are satisfactory, but no better than the old TOs. (46)
- ☐ d. They are unsatisfactory. (18)
- ☐ y. Other or multiple response. (1)
- ☐ z. No responses. (2)

2. The size of the Job Guide Manual is

- ☐ a. Too small. (33)
- ☐ b. Too big. (6)
- ☐ c. Okay. (182)
- ☐ d. Just right. (93)

3. The illustrations are

- ☐ a. Excellent. (71)
- ☐ b. Poor. (45)
- ☐ c. Okay. (197)
- ☐ z. No response. (1)

4. Do the job guide procedures contain all the information you need to do the job?

- ☐ a. Yes, for all jobs. (14)
- ☐ b. Yes, for most jobs. (108)
- ☐ c. Some information is missing for some job guides, but guides are still useful. (161)
- ☐ d. Missing information makes job guides unusable. (30)
- ☐ z. No response. (1)

Note: Questions preceded by an asterisk (*) are classified as questions measuring acceptance. Questions with no asterisk are classified as questions measuring usability.

¹The number in parenthesis following each question indicates the number of responses for that particular question.

5. Are the procedures correct?

- ☐ a. Almost always. (108)
- ☐ b. Mostly. (193)
- ☐ c. Seldom. (12)
- ☐ d. Never. (0)
- ☐ y. Other or multiple response. (1)

6. Do you have any difficulty in understanding the procedures?

- ☐ a. Always. (2)
- ☐ b. Mostly. (7)
- ☐ c. Occasionally. (192)
- ☐ d. Never. (111)
- ☐ y. Other or multiple response. (1)
- ☐ z. No response. (1)

7. Are too many books required to do one Job?

- ☐ a. Always (16)
- ☐ b. Mostly (26)
- ☐ c. Occasionally (164)
- ☐ d. Never (108)

8. Do you find the procedures in the job guides to be too simple (too detailed)?

- ☐ a. Yes, for most jobs (48)
- ☐ b. Yes, for some jobs (96)
- ☐ c. No, about right for most jobs. (176)
- ☐ y. Other or multiple response (2)
- ☐ z. No response (1)

*9. Do you use the dual-level feature?

- ☐ a. Mostly (31)
- ☐ b. Seldom (47)
- ☐ c. What is the dual-level feature? (232)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (3)

10. Have you had any problems with lost, torn, or dirty TO pages?

- ☐ a. Yes, a lot (77)
- ☐ b. Some (100)
- ☐ c. Very little (66)
- ☐ d. No. (71)

*11. Do you use the procedure headings as a checklist?

- ☐ a. Frequently (85)
- ☐ b. Sometimes (164)
- ☐ c. Never (61)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (3)

*12. Would you prefer to use

- ☐ a. Traditional-style TOs (63)
- ☐ b. Job Guide-style TOs (168)
- ☐ c. Checklists (55)
- ☐ d. No TOs (19)
- ☐ y. Other or multiple response (8)
- ☐ z. No responses (1)

*13. What do you think is the best feature of the Job Guides?

- ☐ a. Size (91)
- ☐ b. Simplicity (56)
- ☐ c. Step-by-step procedures (91)
- ☐ d. Illustrations (23)
- ☐ e. Dual-level of instructions (4)
- ☐ f. Other _____ (9)
- ☐ y. Multiple response (39)
- ☐ z. No response (1)

14. Many of the illustrations are printed on fold-out pages. Does this make the illustrations

- ☐ a. Very convenient to use (75)
- ☐ b. No problem to use (179)
- ☐ c. Difficult to use (55)
- ☐ y. Other or multiple response (3)
- ☐ z. No response (2)

15. The illustrations are:

- ☐ a. Necessary to complete most jobs (27)
- ☐ b. Helpful for most jobs (185)
- ☐ c. Helpful but usually not necessary (99)
- ☐ d. Not needed for any job. (1)
- ☐ y. Other or multiple response (2)

16. An index is provided to help you locate information in the job guide manual. The index is:

- ☐ a. Very helpful. Permits rapid location of all job guide information. (149)
- ☐ b. Usually helpful. Aids in locating most required job guide information. (153)
- ☐ y. Other or multiple response (8)
- ☐ z. No response (4)

17. The GAM provides general information on the AC and its systems. How useful is this manual?

- ☐ a. Very useful. Used frequently. (27)
- ☐ b. Somewhat useful. Used occasionally (105)
- ☐ c. Seldom useful. Rarely used. (46)
- ☐ d. Have never used it. (126)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (9)

18. As a source of information for your job, the new job guide manuals are:

- ☐ a. Much better than the old TOs. (44)
- ☐ b. Better than the old TOs, but can be improved. Require refinement. (174)
- ☐ c. No better than the old TOs. (58)
- ☐ d. Worse than the old TOs. (35)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (2)

**19. One of the goals of the JG program is to provide better tech data to encourage use on the job. Do you feel that:

- ☐ a. You use JGMs more than the TOs. (11)
- ☐ b. About the same as the old TOs. (151)
- ☐ c. Less than the old TOs. (48)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (3)

20. How valuable do you think the Job Guides are to OJT?

- ☐ a. Valuable - much better than the old TOs. (157)
- ☐ b. Valuable - about the same as the old TOs. (96)
- ☐ c. Of little value - about the same as the old TOs. (41)

Note: ** Question 19 measures both acceptance and usability.

- ☐ d. Of no value - much worse than the old TOs. (16)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (3)

21. If you are an OJT trainer, how valuable are the Job Guides in helping someone learn the aircraft?

- ☐ a. Very valuable - much better than the old TOs. (134)
- ☐ b. Valuable - about the same as the old TOs. (105)
- ☐ c. Of little value - about the same as the old TOs. (37)
- ☐ d. Of no value - much worse than the old TOs. (15)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (22)

22. Are less experienced technicians doing more work on the aircraft because of detailed procedures in the Job Guides?

- ☐ a. Yes (139)
- ☐ b. No (157)
- ☐ y. Other or multiple response (4)
- ☐ z. No response (14)

*23. Would you recommend that job guide manuals be purchased for use in your shop?

- ☐ a. Yes, for all tasks. (104)
- ☐ b. Yes, for some tasks. (163)
- ☐ c. No. (41)
- ☐ z. No response (6)

*24. Would you recommend that logic tree troubleshooting aids be purchased for use in your shop?

- ☐ a. Yes, for all tasks (90)
- ☐ b. Yes, for some tasks (169)
- ☐ c. No. (44)
- ☐ y. Other or multiple response (1)
- ☐ z. No response (10)

25. Do you think that the new job guide manuals and troubleshooting aids will help you do your job?
- ☐ a. Better (145)
 - ☐ b. About the same. (149)
 - ☐ c. Not as well. (15)
 - ☐ z. No response (5)
- *26. Do you like having detailed step-by-step instructions such as those found in the job guide manuals?
- ☐ a. Yes (205)
 - ☐ b. Makes no difference. (86)
 - ☐ c. No. (16)
 - ☐ y. Other or multiple response (2)
 - ☐ z. No response (5)
- *27. Do you like having detailed illustrations keyed to the step-by-step procedures?
- ☐ a. Yes (221)
 - ☐ b. Makes no difference (78)
 - ☐ c. No (9)
 - ☐ y. Other or multiple response (1)
 - ☐ z. No response (5)
- *28. Which type of technical data would you prefer to use for routine jobs:
- ☐ a. Traditional TO (41)
 - ☐ b. Checklist (105)
 - ☐ c. Job Guide Manuals (116)
 - ☐ d. Very general procedures. (34)
 - ☐ y. Other or multiple response (13)
 - ☐ z. No response (5)

* 29. For non-routine jobs:

- ☐ a. Traditional TO. (70)
- ☐ b. Checklist. (32)
- ☐ c. Job Guide Manual. (182)
- ☐ d. Very general instructions. (18)
- ☐ y. Other or multiple response (7)
- ☐ z. No response (5)

* 30. How do you feel about being required to use job guide manuals for every job?

- ☐ a. Pleased. (41)
- ☐ b. Mostly pleased. (106)
- ☐ c. Somewhat irritated. (117)
- ☐ d. Irritated. (41)
- ☐ y. Other or multiple response (2)
- ☐ z. No response (7)

31. If you were experienced on another aircraft and transferred to work on the C-141, which of the following would be the most helpful to you in becoming qualified on the C-141?

- ☐ a. ATC school. (6)
- ☐ b. FTD school. (90)
- ☐ c. OJT (121)
- ☐ d. Job Guide Manuals and Logic Tree Troubleshooting Aids (34)
- ☐ e. Conventional TO. (12)
- ☐ y. Other or multiple response (42)
- ☐ z. No response (9)

*32. Which of the following do you believe would be the most likely to improve the efficiency of maintenance operations?

- ☐ a. More ATC training. (16)
- ☐ b. Better ATC training. (27)
- ☐ c. Better conventional TOs. (30)
- ☐ d. Job Guide Manuals and Logic Tree Troubleshooting Aids (68)
- ☐ e. More qualified personnel (88)
- ☐ f. Better supply support (43)
- ☐ g. Other or multiple response (35)
- ☐ z. No response (7)

TROUBLESHOOTING

If you have used Logic Tree Troubleshooting Aids (LTTAs), please answer the following four questions. If you have not used LTTAs, please complete the questionnaire by answering question #37.

*33. Logic tree troubleshooting aids (LTTAs) specify the troubleshooting strategy and provide step-by-step instructions for isolating faults.

Do you prefer to:

- ☐ a. Use LTTAs for all troubleshooting tasks. (28)
- ☐ b. Use LTTAs for infrequent troubleshooting tasks only (40)
- ☐ c. Use LTTAs for the most difficult troubleshooting tasks only. (49)
- ☐ d. Develop own troubleshooting strategy and not use LTTAs at all. (26)
- ☐ g. Other or multiple response (3)
- ☐ z. No response (168)

*34. How do you feel about being required to use LTTAs for all troubleshooting jobs?

- ☐ a. Pleased. (22)
- ☐ b. Mostly pleased. (45)
- ☐ c. Somewhat irritated. (51)
- ☐ d. Irritated. (28)
- ☐ z. No response (168)

35. Do the LTTAs lead to correct isolation of the problem?

- ☐ a. Yes, always. (8)
- ☐ b. Usually. (72)
- ☐ c. Sometimes. (54)
- ☐ d. Seldom. (12)
- ☐ z. No response (168)

36. Do LTTAs require more or less time to troubleshoot a problem?

- ☐ a. Less time is required using LTTAs. (38)
- ☐ b. About the same amount of time. (60)
- ☐ c. More time is required when using LTTAs. (45)
- ☐ y. Other or multiple response (3)
- ☐ z. No response (168)

37. If you could influence the purchase of job guide type manuals for a new aircraft, what changes would you recommend?

APPENDIX E

RECOMMENDATIONS AND CHANGES TO THE AFHRL QUESTIONNAIRE

RECOMMENDATIONS AND CHANGES TO THE AFHRL QUESTIONNAIRE

1. Multiple responses. Even though respondents were asked to select only one response, on six questions some respondents chose more than one response. AFHRL recommended that additional instructions be added to their questions 12, 13, 28, 29, 31, and 32 reminding the respondents to choose only one response (39). This change was made to all six questions which were included as questions 20, 21, 36, 37, 39, and 40 in the survey questionnaire. The additional instruction to select only one response should not invalidate the comparison of responses to these six questions with the responses originally obtained by AFHRL.

2. Comparisons with TOs. Questions 18 to 22 on the AFHRL questionnaire requested the respondents to compare job guides with the old C-141A TOs.

The following instruction was placed just before question 26 in the survey questionnaire used in this study: "Question 26 to 30 ask for comparisons between C-141A Job Guides and the old C-141A TOs. If you have not used the old C-141A TOs skip to question 31." In making this change to the AFHRL questionnaire, the following three assumptions were made:

a. It was assumed that during the AFHRL survey all respondents had some knowledge of the old TOs, at least in Air Training Command (ATC) training if not in actual on-the-job use.

b. It was assumed that not all respondents to this survey had some knowledge of the old TOs.

c. Thus, the additional instruction was assumed to provide more comparable data with AFHRL data by allowing recent entries into the career field to skip questions 26 to 30 rather than ask them to choose a response for which they had no basis to answer.

3. Question 1. Because of assumptions a and b made above, AFHRL recommended that one of the responses to their question 1 be changed. This question reads as follows:

How do you like the Job Guide Manuals?

- a. They are completely satisfactory.
- b. They are good, but could be improved.
- c. They are satisfactory, but no better than the old TOs.
- d. They are unsatisfactory.

AFHRL recommended that "but no better than the old TOs" be deleted from response c (39). However, this change would have made the question more confusing by providing two responses that indicated they are "satisfactory."

Attempts to change or clarify response c might make any comparison between responses obtained to this question and those obtained by AFHRL invalid. In deciding not to change response c, it was assumed that respondents would see that the responses were rank-ordered and response c was better than response d but not as good as response b, even if they were not familiar with the old TOs. AFHRL question 1 was retained in its original form and was included in the survey questionnaire as question 9.

4. Question 8. AFHRL question 8 was confusing to some respondents. It read as follows:

Do you find the procedures in the job guides to be too simple (too detailed)?

- a. yes, for most jobs
- b. yes, for some jobs
- c. no, about right for most jobs

This question was intended to determine if the procedures in job guides were so detailed that they made jobs too simple (39). Because of the confusion by respondents on this question, the question was rewritten to more accurately determine if the procedures in job guides were so detailed that they made jobs too simple. The question was rewritten as follows and was included in this survey as question 16.

Do you find the procedures in Job Guides too detailed?

- a. yes, for most jobs
- b. yes, for some jobs
- c. no, about right for most jobs

5. Question 10. AFHRL question 10 asked "Have you had any problems with lost, torn, or dity TO pages? In this instance it was intended for TO to mean job guides, which are a form of TOs. However, some respondents thought the question was asking about TOs other than job guides. AFHRL recommended that "TO" be changed to "Job Guide" (39). This change was made. By changing this question, no comparison could be made with AFHRL responses; however, more accurate data were obtained. AFHRL question 10 was included in the survey questionnaire as question 18.

6. Question 12. AFHRL question 12 asked respondents which kind of tech data they preferred to use in several situations. Response d was "No TOs." This response was intended to mean "no tech data of any kind," but some respondents thought it mean "no TOs, but some other form of tech data" (39). Even though some respondents may be confused by response d, it was not changed so that a comparison could be made with AFHRL responses to this question. AFHRL question 12 was included in the survey questionnaire as question 20.

7. Question 16. AFHRL question 16 reads as follows:

An index is provided to help you locate information in the job guide manual. This index is:

- a. Very helpful. Permits rapid location of all job guide information.
- b. Usually helpful. Aids in locating most required job guide information.

This question was deficient because it provided no negative responses. AFHRL recommended that this question be changed to provide more responses. It was also noted that new and more detailed indexes had been distributed since the AFHRL survey (39). In order to ascertain if respondents to this survey found the revised indexes more useful than respondents in the AFHRL survey found the old indexes question 16 was not changed. Instead, the following new question was added as question 45:

The JGM index is

- a. Very helpful
- b. Usually helpful
- c. Sometimes helpful
- d. Little or no help

This question was added so that a more accurate determination could be made about how useful the respondents perceived the JGM index.

8. Question 21. AFHRL question 21 asked "If you are an OJT trainer, how valuable are the Job Guides in helping someone learn the aircraft?" However, there was no response for respondents who were not OJT trainers. An additional response was added: "e. I am not an OJT trainer." This additional response precluded any comparison of responses with AFHRL responses, but provided more accurate data. AFHRL question 21 was included in the survey questionnaire as question 29.

9. Question 22. AFHRL question 22 read as follows:

Are less experienced technicians doing more work on the aircraft because of detailed procedures in the Job Guides?

- a. Yes
- b. No

This question was confusing to some respondents. Some respondents interpreted it to mean "are less experienced technicians capable of doing more work." Other respondents felt that it meant "are less experienced technicians actually doing more work" (39). Because of this confusion it was not clear if a "yes" response meant that less experienced technicians were actually doing more work or that they were only capable of doing more work. This question was replaced with the following question:

Less experienced technicians are capable of doing more jobs on the aircraft than they could with the old TOs because of the detailed procedures in Job Guides.

- a. I strongly agree
- b. I somewhat agree
- c. I am undecided
- d. I somewhat disagree
- e. I strongly disagree

No attempt was made to compare the response to this question with the responses to question 22 in the AFHRL questionnaire. This new question was included as question 30 in the survey questionnaire.

10. Question 25. AFHRL question 25 read as follows:

Do you think that the new job guide manuals and troubleshooting aids will help you do your job?

- a. Better
- b. About the same
- c. Not as well

The term "will help" was used in this question on the AFHRL Phase I survey before job guides were implemented. This question was not changed on the AFHRL Phase III survey (39). New entries into the career field may have found this question meaningful. However, since job guides have been in use world-wide for about a year, this question as it appears in the AFHRL survey, may not have been as meaningful to older technicians. Therefore, the question was changed to read as follows:

Do you think that the new job guide manuals and troubleshooting aids have helped (or will help) you do your job?

- a. Better
- b. About the same
- c. Not as well

It was assumed that this change would not invalidate the comparison of responses to this question with responses obtained by AFHRL. This question is number 33 in the survey questionnaire. The original question was also somewhat confusing because it asks for a comparison, without specifying what JGMs and LTTAs are to be compared with. It was intended as a comparison between C-141A Job Guides and the old C-141A TOs (39). No attempt, however, was made to clarify this point because it might have invalidated the comparison of responses to this question with responses obtained by AFHRL.

APPENDIX F

TABLE OF VARIABLES AND STATISTICAL TESTS

Table 24

Table of Variables and Statistical Tests

<u>Hyp. #)</u> <u>(Ques. #)</u>	<u>Variable for Testing</u>	<u>Nature of</u> <u>Variable</u> <u>(Compared by)</u>	<u>Level</u> <u>of Data</u> <u>for Tstg</u>	<u>Classif</u> <u>of Data</u> <u>for Tstg</u>	<u>Statistical Test</u>
1 (9)	How C-141A maintenance technicians like C-141A Job Guides as measured by the AFHRL and survey questionnaires.	User Acceptance (Survey)	Ordinal	Discrete Limited	Mann-Whitney
2 (20)	If C-141A maintenance technicians prefer job guides over other forms of technical data as measured by the AFHRL and survey questionnaires.	User Acceptance (Survey)	Nominal	Discrete Limited	χ^2 -Two Sample
2a (36)	If C-141A maintenance technicians prefer JGMs over other forms of technical data for routine jobs as measured by the AFHRL and survey questionnaires.	User Acceptance (Survey)	Nominal	Discrete Limited	χ^2 -Two Sample

Table 24 (continued)

Hyp. # (Ques. #)	Variable for Testing	Nature of Variable (Compared by)	Level of Data of Data for Tstg	Classif of Data	Statistical Test
2b (37)	If C-141A maintenance technicians prefer JGMs over other forms of technical data for non-routine jobs as measured by the AFHRL and survey questionnaires.	User Acceptance (Survey)	Nominal	Discrete Limited	χ^2 -Two Sample
3 (27)	If C-141A maintenance technicians feel they use JGMs more than the old TOS as measured by the AFHRL and survey questionnaires.	User Acceptance (Survey)	Ordinal	Discrete Limited	Mann-Whitney
3 (27)	If C-141A maintenance technicians feel they use JGMs more than the old TOS as measured by the AFHRL and survey questionnaires.	Perceived Usability (Survey)	Ordinal	Discrete Limited	Mann-Whitney

Table 24 (continued)

Hyp.# (Ques.#)	Variable for Testing	Nature of Variable (Compared by)	Level of Data of Data for Tstg	Classif of Data for Tstg	Statistical Test
4 (26)	If C-141A maintenance technicians feel that C-141A Job Guides are a better source of information for their jobs than the old TOS as measured by the AFHRL and survey questionnaires.	Perceived Usability (Survey)	Ordinal	Discrete Limited	Mann-Whitney
5 (28)	If C-141A maintenance technicians feel that job guides are more valuable for OJT than the old TOS as measured by the AFHRL and survey questionnaires.	Perceived Usability (Survey)	Ordinal	Discrete Limited	Mann-Whitney

Table 24 (continued)

<u>Hyp. #</u> <u>(Ques. #)</u>	<u>Variable for Testing</u>	<u>Nature of</u> <u>Variable</u> <u>(Compared by)</u>	<u>Level</u> <u>of Data</u>	<u>Classif</u> <u>of Data</u> <u>for Tstg</u>	<u>Statistical Test</u>
6 (33)	If C-141A maintenance technicians feel that JGMS and LPTAS will help them do their job better as measured by the AFHRL and survey questionnaires.	Perceived Usability (Survey)	Ordinal	Discrete Limited	Mann-Whitney
7 (44)	If C-141A maintenance technicians feel that LPTAS require less time to troubleshoot than the old TOs as measured by the AFHRL and survey questionnaires.	Perceived Usability (Survey)	Ordinal	Discrete Limited	Mann-Whitney
8 (9)	How C-141A maintenance technicians like C-141A Job Guides as measured by the survey questionnaire.	User Acceptance (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis

Table 24 (continued)

Hyp. # (Ques. #)	Variable for Testing	Nature of Variable (Compared by)	Level of Data	Classif. of Data for Tstg	Statistical Test
9 (20)	If C-141A maintenance technicians prefer job guides over other forms of technical data as measured by the survey questionnaire.	User Acceptance (Grade)	Nominal	Discrete Limited	χ^2 -K Sample
9a (36)	If C-141A maintenance technicians prefer JGMs over other forms of technical data for routine jobs as measured by the survey questionnaire.	User Acceptance (Grade)	Nominal	Discrete Limited	χ^2 -K Sample
9b (37)	If C-141A maintenance technicians prefer JGMs over other forms of technical data for non-routine jobs as measured by the survey questionnaire.	User Acceptance (Grade)	Nominal	Discrete Limited	χ^2 -K Sample

Table 24 (continued)

Hyp. # (Ques. #)	Variable for Testing	Nature of Variable (Compared by)	Level of Data of Data for Tstg	Classif of Data for Tstg	Statistical Test
10 (27)	If C-141A maintenance technicians feel they use JGMs more than the old TOs as measured by the survey questionnaire.	User Acceptance (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis
10 (27)	If C-141A maintenance technicians feel they use JGMs more than the old TOs as measured by the survey questionnaire.	Perceived Usability (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis
11 (26)	If C-141A maintenance technicians feel that C-141A Job Guides are a better source of information for their jobs than the old TOs as measured by the survey questionnaire.	Perceived Usability (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis

Table 24 (continued)

Hyp. # (Ques. #)	Variable for Testing	Nature of Variable (Compared by)	Level of Data of Data for Tstg	Classif of Data	Statistical Test
12 (28)	If C-141A maintenance technicians feel that job guides are more valuable for OJT than the old TOS as measured by the survey questionnaire.	Perceived Usability (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis
13 (33)	If C-141A maintenance technicians feel that JGMS and I/TAS will help them do their job better as measured by the survey questionnaire.	Perceived Usability (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis
14 (44)	If C-141A maintenance technicians feel that I/TAS require less time to troubleshoot than the old TOS as measured by the survey questionnaire.	Perceived Usability (Grade)	Ordinal	Discrete Limited	Kruskal-Wallis

APPENDIX G

MANN-WHITNEY RANK SUM TEST COMPUTER PROGRAM

MANN-WHITNEY RANK SUM TEST COMPUTER PROGRAM

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010      DIMENSION OLD(4),NEW(4), RANGE(4),W(4),RANK(4),
015&      ARANK(4),PRANK(4),TI(4)
020      PRINT,"ENTER THE CURRENT SURVEY SAMPLE SIZE"
025      READ,N2
030      PRINT,"ENTER THE AFHRL SAMPLE SIZE"
035      READ,N1
040      PRINT,"ENTER THE SUM OF BOTH SAMPLES"
045      READ,N
050      EW=(.5*N2)*(N1+N2+1)
055      CVR=1.645
060      CVT=-1.96
065C
070      1 PRINT,"ENTER THE CURRENT SURVEY VALUES"
075      READ, OLD(1), OLD(2), OLD(3), OLD(4)
080      IF(OLD(1).GE.999)GO TO 11
085      PRINT,"ENTER THE AFHRL VALUES"
090      READ, NEW(1), NEW(2), NEW(3), NEW(4)
095      ST=0
100      DO 2 I=1,4
105          TI(I)=(OLD(I)+NEW(I))*3-(OLD(I)+NEW(I))*(1.0/12)
110          ST=ST+TI(I)
115      2 CONTINUE
120      V=N1*N2
125      Q=N*(N-1)
130      X=V/Q
135      YY=((N**3)-N)/12)
140      Y=YY-ST
145      Z=X*Y
150      SD=SQRT(Z)
155      RANGE(0)=0
160      PRANK(0)=0
165      RANK(0)=0
170C
175      DO 3 I=1,4
180          RANGE(I)=OLD(I)+NEW(I)+RANGE(I-1)
185          PRANK(I)=(RANGE(I)*(RANGE(I)+1))/2
190          RANK(I)=PRANK(I)-PRANK(I-1)
195          ARANK(I)=RANK(I)/(OLD(I)+NEW(I))
200      3 CONTINUE
205C
210      SW=0
215      DO 4 I=1,4
220          W(I)=ARANK(I)*OLD(I)
225          SW=SW+W(I)
230      4 CONTINUE
235C

```

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240      ZW=(SW-EW)/SD
245      IF(ZW.GE.0)GO TO 6
250      PRINT," "
255      PRINT,"MOVEMENT IS NOT"
260      PRINT,"IN THE PREDICTED DIRECTION"
265      PRINT,"WITH A TWO TAILED TEST"
270      PRINT,"AT THE .05 ALPHA LEVEL"
275      IF(ZW.LT.CVT)GO TO 5
280      PRINT,"THE MOVEMENT IS NOT"
285      PRINT,"STATISTICALLY SIGNIFICANT"
290      GO TO 8
295      5 PRINT,"THE MOVEMENT IS"
300      PRINT,"STATISTICALLY SIGNIFICANT"
305      GO TO 8
310C
315      6 PRINT," "
320      PRINT,"MOVEMENT IS IN THE PREDICTED DIRECTION"
325      IF(ZW.GT.CVR)GO TO 7
330      PRINT,"MOVEMENT IS NOT STATISTICALLY SIGNIFICANT"
335      PRINT,"AT THE .05 ALPHA LEVEL"
340      GO TO 8
345      7 PRINT,"MOVEMENT IS STATISTICALLY SIGNIFICANT"
350      PRINT,"AT THE .05 ALPHA LEVEL"
355C
360      8 IF(ZW.GE.0)GO TO 9
365      PRINT 7002,CVT
370      GO TO 10
375      9 PRINT 7002,CVR
380      10 PRINT 7001,ZW
385      GO TO 1
390      11 STOP
395C
400 7001 FORMAT (1X,"THE COMPUTED Z VALUE IS      ",
405&          F7.3,////)
410 7002 FORMAT (/ ,1X,"THE CRITICAL Z VALUE IS      ",
415&          F7.3,/)
420      END

```

APPENDIX E
DEMOGRAPHIC COMPARISONS

Table 25

Demographic Comparisons

<u>Demographic Variable</u>	<u>Survey</u>		<u>Population</u>
Category	AFHRL	Current	Current
	(Percent)		(Percent)
<u>Pay Grade</u>			
E1	0.0	0.0	1.4
E2	7.6	3.3	8.1
E3	21.0	19.3	24.3
E4	29.0	26.4	31.2
E5	11.5	18.2	15.3
E6	1.9	7.1	5.4
E7	1.9	3.7	2.3
E8	0.6	1.5	1.9
E9	0.0	0.0	0.6
WG 10	19.4	9.3	
WG 11	6.7	10.4	9.5
not identified	0.3	0.4	N/A
<u>AFSC</u>			
325X0	3.8	5.8	3.0 ¹
325X1	5.7	11.2	4.6
328X0	6.1	4.5	3.5
328X1	7.0	3.7	4.8
328X4	4.5	7.8	2.7
423X1	5.4	1.1	3.3
423X3	1.9	0.4	1.9
423X4	0.0	0.4	4.4
423X6	0.3	0.0	0.0
423X9	0.0	0.0	0.4
426X2	6.7	3.7	19.8
431X1	44.9	55.8	50.0
not identified	13.7	6.7	N/A
<u>Skill Level</u>			
3	7.0	7.4	14.2 ²
5	65.3	60.3	71.3
7	25.5	28.6	11.5
9	0.6	3.7	3.0
not identified	1.6	0.0	N/A

Table 25 (continued)

<u>Demographic Variables</u> <u>Category</u>	<u>Survey</u> <u>AFHRL</u> <u>Current</u> (Percent)		<u>Population</u> <u>Current</u> (Percent)
<u>Type Squadron</u>			
AMS	32.2	33.5	19.0
FMS	34.4	31.2	39.7
OMS	33.4	34.9	41.3
not identified	0.0	0.4	N/A
<u>Base</u>			
Charleston	48.7	N/A	N/A
Norton	51.3	N/A	N/A
McChord	N/A	50.9	53.5
McGuire	N/A	49.1	46.5
<u>Time in Aircraft Maintenance</u>			
less than 6 months	N/A ³	2.2	N/A ³
6 months to 2 years	N/A	20.8	N/A
2 years to 4 years	N/A	21.9	N/A
4 years to 8 years	N/A	17.5	N/A
8 years to 12 years	N/A	10.0	N/A
over 12 years	N/A	26.8	N/A
not identified	N/A	.7	N/A
<u>Time in C-141A Maintenance</u>			
less than 6 months	N/A ³	4.8	N/A ³
6 months to 2 years	N/A	30.1	N/A
2 years to 4 years	N/A	27.5	N/A
4 years to 8 years	N/A	19.3	N/A

Table 25 (continued)

<u>Demographic Variable</u> Category	<u>Survey</u>		<u>Population</u>
	AFHRL	Current	Current
8 years to 12 years	N/A	14.9%	N/A
over 12 years	N/A	2.6%	N/A
not identified	N/A	.7%	N/A

¹Does not include proportions of civilians in each AFSC.

²Does not include proportions of civilians in each skill level.

³Data not available.

APPENDIX I
COMPARISONS OF QUESTIONS BY SURVEY

Table 26
Comparisons of Questions By Survey

AFHRL Question Number	CS Question Number	Acceptance or Usability	Level of Data	Significant at .05 Level	Direction of Movement	Level of Significance
1	9	Acceptance	Ordinal	Yes	+	.0475 < p < .0485
2	10	Usability	Nominal	Yes	-	p = .0008
3	11	Usability	Ordinal	No	+	.0618 < p < .0630
4	12	Usability	Ordinal	No	-	.0854 < p < .0872
5	13	Usability	Ordinal	Yes	+	p = .0294
6	14	Usability	Ordinal	Yes	+	.00001 < p < .00002
7	15	Usability	Ordinal	Yes	+	.0268 < p < .0274
9	17	Acceptance	Nominal	No	+	p = .2558
10	18	Usability	Ordinal	No	-	.4592 < p < .4654
11	19	Acceptance	Ordinal	No	-	.2186 < p < .2224
12	20	Acceptance	Nominal	Yes	+	p = .0191
13	21	Acceptance	Nominal	No	0	p = .0868
14	22	Usability	Ordinal	No	+	.1075 < p < .1093
15	23	Usability	Ordinal	No	-	.5418 < p < .5486
16	24	Usability	Ordinal	Yes	+	p = .0010
17	25	Usability	Ordinal	No	-	.0672 < p < .0688
18	26	Usability	Ordinal	No	+	.2148 < p < .2177
19	27	Both	Ordinal	No	+	.2389 < p < .2420
20	28	Usability	Ordinal	No	+	.0630 < p < .0643
23	31	Acceptance	Ordinal	Yes	+	.0202 < p < .0207
24	32	Acceptance	Ordinal	No	+	.0655 < p < .0668
25	33	Usability	Ordinal	Yes	+	.0250 < p < .0256
26	34	Acceptance	Ordinal	Yes	+	.0217 < p < .0222

Table 26 (continued)

AFHRL Question Number	CS Question Number	Acceptance or Usability	Level ¹ of Data	Significant at .05 Level	Direction ² of Movement	Level of Significance
27	35	Acceptance	Ordinal	Yes	+	.0427 < p < .0436
28	36	Acceptance	Nominal	No	+	p = .1229
29	37	Acceptance	Nominal	Yes	+	p = .0050
30	38	Acceptance	Ordinal	Yes	+	p = .0436
31	39	Usability	Nominal	No	+	p = .3695
32	40	Acceptance	Nominal	Yes	+	p = .0040
33	41	Acceptance	Ordinal	No	+	.1736 < p < .1762
34	42	Acceptance	Ordinal	Yes	+	.0344 < p < .0351
35	43	Usability	Ordinal	Yes	+	.0146 < p < .0150
36	44	Usability	Ordinal	Yes	+	p = .0392

¹When ordinal level data were present the Mann-Whitney Rank Sum Test was used to test for significance. When only nominal data were present the χ^2 test was used to test for significance.

² + means movement is in the predicted direction, 0 means direction of movement cannot be determined, and - means movement is not in the predicted direction.

APPENDIX J

COMPARISONS OF QUESTIONS BY TIME
RELATED VARIABLES

COMPARISONS OF QUESTIONS BY TIME
RELATED VARIABLES

Testing for Significance

The variables represented by the question numbers shown in the extreme left column of the table were tested for a statistically significant difference on the variables shown horizontally across the table. The test used was the chi square test for significance with an alpha level of .05. In general, this test requires that the expected number of observations in each cell be greater than or equal to five for at least for 80 percent of the cells (38:178). In order to meet this requirement, some of the categories had to be combined for each of the variables tested. The original categories along with the categories used to conduct the statistical tests are as follows:

<u>Variable</u>	<u>Original Categories</u>	<u>Categories Used for Testing</u>
Pay Grade	E2 E3 E4 E5 E6 E7 E8 WG 10 WG 11	E2 and E3 E4 E5 E6, E7, and E8 WG 10 and WG 11

<u>Variable</u>	<u>Original Categories</u>	<u>Categories Used for Testing</u>
Time spent in air- craft maintenance	0-6 months 6 months-2 years 2-4 years 4-8 years 8-12 years over 12 years	0-2 years 2-4 years 4-8 years over 8 years
Time spent in C-141A maintenance	0-6 months 6 months-2 years 2-4 years 4-8 years 8-12 years over 12 years	0-2 years 2-4 years 4-8 years over 8 years

Table 27
Comparisons of Questions By Time Related Variables

CS Question Number	Acceptance or Usability	Significant By Pay Grade	Significant By Time Spent in Aircraft Maintenance	Significant By Time Spent in C-141A Maintenance
9	Acceptance	No	Yes	No
10	Usability	No	Yes	Yes
11	Usability	No	No	No
12	Usability	No	No	No
13	Usability	Yes	No	No
14	Usability	No	No	No
15	Usability	No	Yes	Yes
16	Usability	No	No	No
17	Acceptance	No	No	No
18	Usability	No	No	No
19	Acceptance	No	No	No
20	Acceptance	Yes	No	No
21	Acceptance	No	No	No
22	Acceptance	No	No	No
23	Usability	No	No	No
24	Usability	No	No	No
25	Usability	Yes	Yes	No
26	Usability	No	Yes ¹	Yes ¹
27	Both	No	No	No
28	Usability	No	No	No
29	Usability	No	No	No
30	Usability	No	No	No
31	Acceptance	No	No	No

Table 27 (continued)

CS Question Number	Acceptance or Usability	Significant By Pay Grade	Significant By Time Spent in Aircraft Maintenance	Significant By Time Spent in C-141A Maintenance
32	Acceptance	No	Yes	Yes
33	Usability	Yes	Yes	Yes
34	Acceptance	Yes	Yes	Yes
35	Acceptance	Yes	No	Yes
36	Acceptance	Yes	Yes	Yes
37	Acceptance	Yes	Yes	No
38	Acceptance	No	Yes	Yes
39	Usability	No	No	No
40	Acceptance	Yes	Yes	Yes
41	Acceptance	No	No	No
42	Acceptance	No	No	No
43	Usability	No	Yes	No
44	Usability	No	No	No
45	Usability	No	No	No
46	Acceptance	No	No	No

¹Question was significant in the opposite direction from that predicted.

SELECTED BIBLIOGRAPHY

A. REFERENCES CITED

1. Air Force Logistics Command (AFLC), Warner Robins Air Logistics Center (ALC)/XRM Message (DTG 131830Z), subject: C-141 Job Guide Manuals, to ASD Wright-Patterson AFB OH/RM, 13 Feb 1976.
2. Air Force Military Survey Program, "A Guide for the Development of the Attitude and Opinion Survey," Pamphlet. Headquarters U.S. Air Force/ACM, Pentagon, Washington, D.C., October 1974.
3. Albrook, Robert. "Participative Management: Time for a Second Look," in John G. Hutchinson, Readings in Management. New York: Holt Rinehart and Winston, Inc., 1971
4. Argyris, Chris. Intervention Theory and Method A Behavioral Science View. Reading, Massachusetts: Addison-Wesley Publishing Company, 1970.
5. Ashbaugh, Captain Dennis M., USAF, and Captain Larry J. Godfrey, USAF. "The Impact of the SAC Missile Management Working Group on Missile Combat Crew Member Attitudes." Unpublished master's thesis. SLSR 14-76B, AFIT/SL, Wright-Patterson AFB OH 1976.
6. Bent, Dale H., C. Hadlai Hull, Jean G. Jenkins, Norman H. Nie, and Karin Steinbrenner. SPSS Statistical Package for the Social Sciences. New York: McGraw-Hill Book Company, Inc., 1975.
7. Carvell, Fred J. Human Relations in Business. 2nd ed. New York: MacMillian Publishing Company, Inc., 1975.
8. Champion, Dean J. The Sociology of Organizations. New York: McGraw-Hill Book Company, 1975.
9. Chief of Staff Air Force (CSAF)/LGYE. Message (DTG 172154Z), subject: Maintenance Performance Aids C-141 Evaluation to HQ AFLC/MMO, 17 Dec 1975.

10. Coch, Lester, and John R. P. French, Jr. "Overcoming Resistance to Change," in Dorwin Cartwright, and Alvin Zander, eds., Group Dynamics: Research and Theory. 3rd ed. New York: Harper and Row, Publishers, 1968.
11. Costello, Timothy W., and Sheldon S. Zalkind. Psychology in Administration A Research Orientation. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963.
12. Eckstrand, Gordon A. Director, AF Human Resources Laboratory (HRL)/AS, Wright-Patterson AFB OH. Letter, subject: Technical Data Program, to AFHRL/CC Brooks AFB TX, 23 May 1975.
13. Filley, Alan C., Robert J. House, and Steven Kerr. Managerial Process and Organizational Behavior. 2nd ed. Glenview, Illinois: Scott, Foresman and Company, 1976.
14. Flippo, Edwin B. Principles of Personnel Management. New York: McGraw-Hill Inc., 1971.
15. French, J. R. P., Jr., J. Israel, and As., D. "An Experiment on Participation in a Norwegian Factory," Human Relations, XIII (January-February, 1960), pp. 3-19.
16. Gansler, Jacques S. "Maintenance Performance Aids," Memorandum for Assistant Secretaries of the Air Force (I&L) and (R&D). OASD, Office of the Director of Defense Research and Engineering, Washington, D.C., 17 Sep 1975.
17. _____, and John L. Allen. "Maintenance Performance Aids," Memorandum for Assistant Secretaries of the Air Force (I&L), (R&D), and (M&RA). OASD, Office of the Director of Defense Research and Engineering, Washington, D.C., 2 Oct 1975.
18. Hersey, Paul, and Kenneth H. Blanchard. Management of Organizational Behavior. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969.

19. Hodge, Billy J., and Herbert J. Johnson. Management and Organizational Behavior: A Multidimensional Approach. New York: John Wiley and Sons, Inc., 1970.
20. Jackson, Donald L. Assistant to the Director, Maintenance Engineering and Supply, LGY, HQ USAF. Letter, subject: Evaluation of Technical Order Improvement Program (TOIP) Data, to AFLC/TMD and MAC/LG, 11 June 1975.
21. Johnson, Robert C. Air Force Human Resources Laboratory (AFHRL/ASR), Wright-Patterson AFB OH. Personal interview. 10 November 1976.
22. _____. "C-141 Job Guide Manual Evaluation," Staff Study Working Draft. AF Human Resources Laboratory (AFHRL/ASR), Wright-Patterson AFB OH, undated.
23. _____, and Donald L. Thomas. "To Collect Data for the C-141 JPA Utilization Study," Trip Report. AF Human Resources Laboratory (AFHRL/ASR), Wright-Patterson AFB OH, 16 Dec 1975.
24. _____. AF Human Resources Laboratory (AFHRL/ASR), Wright-Patterson AFB OH. Personal interview. 17 February 1977.
25. Kast, Fremont E., and James E. Rosenzweig. Organization and Management: A Systems Approach. New York: McGraw-Hill Book Company, Inc., 1974.
26. Kerr, E. B., and S. Kerr. "Why Your Employees Resist Perfectly 'Rational' Changes," as cited in Alan C. Filley, Robert J. House, and Stephen Kerr Managerial Process and Organizational Behavior. 2nd ed. Glenview, Illinois: Scott, Foresman and Company, 1976.
27. Lawrence, P. R. "How to Deal With Resistance to Change," as cited in Alan C. Filley, Robert J. House, and Steven Kerr Managerial Process and Organizational Behavior. 2nd ed. Glenview, Illinois: Scott, Foresman and Company, 1976.

28. Mann, F. C., and F. W. Neff. "Involvement and Participation in Change," in Timothy W. Costello and Sheldon S. Zalkind Psychology in Administration: A Research Orientation. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963.
29. Marrow, Alfred J., David G. Bowers, and Stanley E. Seashore. Management by Participation. New York: Harper and Row Publishers, 1967.
30. McGuire, W. J. "The Nature of Attitudes and Attitude Change," in G. Lindzey and E. Aronson (eds.) Handbook of Social Psychology. 2nd ed., Vol. 3 (1969), as cited in Encyclopedia Britannica, Inc. Chicago, Illinois: William Benton Publisher, 1974.
31. Military Airlift Command (MAC)/LG. Message (DTG 222200Z), subject: C-141 Acft Job Guide Manual Orientation/Test, to 437 MAW Charleston AFB SC/MA/MAO and others, 22 Aug 1975.
32. ———. Message (DTG 241800Z), subject: C-141 JGM Usability and Acceptance Questionnaire, to 62 MAW McChord AFB WA/MA/MAI; 438 MAW McGuire AFB NJ/MA/MAI; and others; 24 Feb 77.
33. Morgan, Ross L., and Robert C. Johnson. "Evaluation of JPAs for C-141," Trip Report. AF Human Resources Laboratory (AFHRL)/ASR, Wright-Patterson AFB OH, 25 Sep 1975.
34. Newman, William H., Charles E. Summer, and E. Kirby Warren. The Process of Management. 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967.

35. Potter, Norman R., and Donald L. Thomas. "Evaluation of Three Types of Technical Data for Trouble-shooting." Unpublished research report (results and project summary), unnumbered, Systems Research Laboratories, Inc., Dayton, Ohio; Air Force Human Resources Laboratory, Wright-Patterson AFB OH, undated.
36. Rokeach, Milton. Beliefs, Attitudes, and Values. San Francisco, California: Jossey-Bass, Inc., 1968.
37. Rowan, T. C. "Improving DoD Maintenance Through Better Performance Aids." Advanced Research Project Agency Order No. 2244, Program Code 3D20, 1 March 1973.
38. Siegel, Sidney. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill Book Company, Inc., 1956.
39. Thomas, Donald L. Air Force Human Resources Laboratory (AFHRL)/ASR, Wright-Patterson AFB OH. Personal interview. 17 February 1977.
40. Thomas, Kerry (ed.). Attitudes and Behavior. Baltimore, Maryland: Penguin Books, Inc., 1971.
41. Triandis, Harry C. Attitude and Attitude Change. New York: John Wiley and Sons, Inc., 1971.
42. Tuccy, J. "SPSS Subprogram NPAR Tests: Nonparametric Statistical Tests," Manual N. 324 (Rev. B). Northwestern University, Vogelback Computing Center, Evanston, Illinois, April 1976.
43. U.S. Air Force Institute of Technology. School of Systems and Logistics, Department of Quantitative Studies. Statistics II Handout No. 15, Mann-Whitney Rank Sum Test. Wright-Patterson AFB OH, undated.
44. Wieland, George F., and Robert A. Ullrich. Organizations: Behavior, Design, and Change. Homewood, Illinois: Richard D. Irwin, Inc., 1976.

B. RELATED SOURCES

- Allport, G. W. Pattern and Growth in Personality. New York: Holt, Rinehart and Winston, Inc., 1961.
- Argyris, Chris. "Interpersonal Barriers to Decision Making," Harvard Business Review, March-April, 1966.
- Bennis, Warren G. Changing Organizations. New York: McGraw-Hill Book Company, 1966.
- Carlisle, Howard M. Management Concepts and Situations. Chicago, Illinois: Science Research Associates, 1976.
- Champion, John M., and Francis T. Bridges. Critical Incidents in Management (Rev Ed). Homewood, Illinois: Richard D. Irwin, Inc., 1969.
- Dalton, Gene W., and Paul R. Lawrence (eds). Motivation and Control in Organizations. Homewood, Illinois: Richard D. Irwin, Inc. and the Dorsey Press, 1971.
- Dunn, J. D., and Elvis C. Stephens. Management of Personnel. New York: McGraw-Hill, Inc., 1972.
- Emory, William C. Business Research Methods. Homewood, Illinois: Richard D. Irwin, Inc., 1976.
- Fishbein, Martin. Attitude Theory and Measurement. New York: John Wiley and Sons, Inc., 1961.
- Foley, John P., Jr., and William B. Camm. "Job Performance Aids Research Summary." Unpublished research report, unnumbered, Advanced Systems Division, Air Force Human Resources Laboratory, Air Force Systems Command, Wright-Patterson AFB OH, August 1972.
- French, J. R. P., Jr. "Split Roles in Performance Appraisal," Harvard Business Review, January-February, 1965, pp. 123-129.
- Fulmer, Robert M. The New Management. New York: MacMillan Publishing Company, Inc., 1974.

Hutchinson, John G. Readings in Management Strategy and Tactics. New York: Holt, Rinehart, and Winston, Inc., 1971.

Johnson, Robert C., and Donald L. Thomas. No Title (Subject/Purpose: "To Collect Data via Questionnaires, Interviews, and Observation for the Third Phase of the Study of User Acceptance and Usability of the C-141 Job Guide Manuals") Trip Report. AF Human Resources Laboratory (AFHRL)/ASR, Wright-Patterson AFB OH, 6 Aug 1976.

Kazmier, Leonard J. Principles of Management. 2nd ed. New York: McGraw-Hill, Inc., 1969.

Lawrence, P. R. "How to Deal with Resistance to Change," as cited in Alan C. Filley, Robert J. House, and Steven Kerr Managerial Process and Organizational Behavior. 2nd ed. Glenview, Illinois: Scott, Foresman and Company, 1976.

Mann, F. C., and F. W. Neff. "Involvement and Participation in Change," in Timothy W. Costello and Sheldon S. Zalkind Psychology in Administration A Research Orientation. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1963.

Nelson, Gary R., Robert M. Gay, and Charles Robert Roll, Jr. "Reducing Manpower and Personnel Costs In Electronics Maintenance: Framework and Recommendations." Unpublished research report No. WN-8544-ARPA, ARPA Order No. 189-1, DAHC1573CO181, RAND Corporation, Santa Monica, California, January, 1974.

Perrow, Charles. Complex Organizations. Glenview, Illinois: Scott, Foresman and Company, 1972.

Roethlisberger, Fritz Jules, and William J. Dickson. Management and the Worker. Cambridge, Massachusetts: Harvard University Press, 1939.

Simon, Herbert A. Administrative Behavior. 3rd ed. New York: MacMillan Publishing Company, Inc., 1976.

Strauss, George. Personnel, The Human Problems of Management. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1972.

Tabb, J. Y., and A. Goldfarb. Workers' Participation in Management. New York: Pergamon Press, 1970.

Tucker, Robert G. Chief, Aircraft and Missile Management Section, Directorate of Materiel Management/MMSTA, HQ Warner Robbins Air Logistics Center (AFLC). Letter, subject: AFHRL/ASR Trip Report dated 16 Dec 1975, C-141 Job Guide Manual Evaluation, to AF Human Resources Laboratory (AFHRL)/ASR, Wright-Patterson AFB OH, 9 Feb 1976.

BIOGRAPHICAL SKETCHES

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Major S. A. Richardson was commissioned in 1961 after graduating with a Bachelor of Science degree from the University of Georgia. He has served in SAC, PACAF, MAC, and USAFE in the fuels and cryogenics and energy management career fields. He came to AFIT following a staff assignment as Chief, Energy Management Division, HQ USAFE. His next assignment after graduation is to HQ Supreme Allied Command Atlantic (SACLANT), Norfolk NAS, Virginia as a logistics staff officer.

Captain Thomas E. Syster was commissioned in 1968 after graduating with a Bachelor of Arts degree from Doane College. He has served in AFCS in a variety of communications electronics positions. He came to AFIT following a career broadening assignment as a communications exchange officer with the Royal Australian Air Force. After graduation, his next assignment is to HQ AFCS, Richard Gebaur AFB, Missouri in the Plans Directorate.

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